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**U.S. Army  
Environmental  
Center**

**NO FURTHER ACTION DECISION UNDER CERCLA**

**FORT DEVENS STUDY AREA 19, 20 AND 21  
WASTE WATER TREATMENT PLANT**

**CONTRACT DAAA15-91-D-0008**

**U.S. ARMY ENVIRONMENTAL CENTER  
ABERDEEN PROVING GROUND, MARYLAND**

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STUDY AREAS 19, 20 and 21  
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FORT DEVENS, MASSACHUSETTS**

*Prepared for:*

U.S. Army Environmental Center  
Aberdeen Proving Ground, Maryland  
Contract DAAA15-91-0008

*Prepared by:*

ABB Environmental Services, Inc.  
Wakefield, Massachusetts  
Project No. 6917-11

NOVEMBER 1995

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## EXECUTIVE SUMMARY

Investigations of Study Areas 19, 20 and 21 (Waste Water Treatment Plant) at Fort Devens, Massachusetts, have resulted in the decision that no further hazardous waste studies or remediation are required at this site. Any further action should be addressed under applicable sanitary sewage regulations and standards. Study Areas 19, 20 and 21 were identified collectively in the Federal Facilities Agreement between the U.S. Environmental Protection Agency and the U.S. Department of Defense as a potential site of contamination.

On December 21, 1989 Fort Devens was placed on the National Priorities List under the Comprehensive Environmental Response, Compensation and Liability Act as amended by the Superfund Amendments and Reauthorization Act. Fort Devens was subsequently selected for cessation of operations and closure under Public Law 101-510, the Defense Base Realignment and Closure Act of 1990. In accordance with these acts numerous studies have been conducted which address Study Areas 19, 20 and 21, including a Master Environmental Plan, an Enhanced Preliminary Assessment, and a Site Investigation.

The site investigation of Study Areas 19, 20 and 21 was initiated in 1992 in conjunction with the other eight Group 3, 5 and 6 Study Areas at Fort Devens. The Study Areas 19, 20 and 21 site investigations consisted of both Study Area-specific investigations (on groundwater and surface soil) and non-Study Area-specific investigations of the whole Group 5 area (on surface water and sediment in the Nashua River).

Sixteen monitoring wells had been previously installed to evaluate the effectiveness of the wastewater treatment plant infiltration beds (Study Area 20). Three additional monitoring wells were installed during the site investigation near the Waste Water Treatment Plant as part of the Study Area 09 (North Post Landfill) site investigation. Two rounds of groundwater samples and water table measurements, collected three months apart, were obtained from the three new monitoring wells and 16 existing monitoring wells during the site investigation. Due to a cross contamination incident during the second sampling round, a third round of groundwater samples was collected for volatile organic compounds.

The forested floodplain located down slope from the sludge drying beds is dominated by red maple, American elm, and white pine. Other trees observed include pitch pine, black cherry, white oak, European buckthorn, and white birch.

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## **EXECUTIVE SUMMARY**

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The understory includes cinnamon fern and Japanese knotweed. The area likely provides cover and foraging habitat for a variety of wetlands and semi-terrestrial wildlife including passerine songbirds, mammals such as raccoon and mink, amphibians, reptiles, and a variety of invertebrates.

In an effort to characterize the nature of contamination in soils, two soil samples were collected at the surface (0 to 2 feet below grade) from the Nashua River floodplain located down slope of the waste water treatment plant sludge drying beds. The samples were analyzed for a full suite of contaminants. Based on the laboratory results, it was determined that the extent of contamination was not fully characterized. Twelve additional soil samples were collected during a supplemental site investigation, 10 from the surface and two from the depth interval of 2 to 4 feet below grade. In April 1995 three additional surface soil samples were collected during an April 11, 1995 sampling event.

Ten sets of surface water and sediment samples were collected from the Nashua River during the site investigation. Sample locations were spaced along the Nashua River both upgradient and downgradient of the Group 5 Study Areas, as a means of assessing contaminated groundwater discharging to the river. Two additional sediment samples were collected during the April 11, 1995 sampling event.

Laboratory results indicated that groundwater contamination downgradient from the waste water treatment plant consisted of elevated concentrations of nitrates in excess of the Massachusetts Maximum Contaminant Level. A localized zone of volatile organic compound contamination was observed and determined to be attributable to an incidental release of Hypalon liner adhesive used in repairing the sludge drying beds in May 1991. The detected contaminant concentrations were low, decreasing in successive sampling rounds and posing no significant threat to human health or the environment.

Shallow soil samples collected from the Nashua River floodplain near Study Area 21 showed elevated concentrations of inorganic analytes. The subset of these analytes generally associated with waste water treatment plant sludge, were observed in a discrete zone located downslope of a former sludge-drying bed underdrain (no longer in use). The lateral extent of this localized zone of contamination was determined to be roughly 1,500 square feet in area. The other inorganic analytes detected in soil are likely attributable to flood deposits of the Nashua River. Deeper soil samples adjacent to the sludge drying beds exhibited

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significantly lower concentrations of inorganic analytes, suggesting limited downward migration. Total petroleum hydrocarbon compounds detected in soil, in the absence of other organic compounds, were determined to be the result of natural organic material (leaf litter) in the floodplain.

Because surface water and sediment contamination of the Nashua River is not attributable to any one specific source, the Army, in agreement with the regulatory agencies, has addressed these contaminant issues under a comprehensive storm water runoff study (Area Requiring Environmental Evaluation 70).

On the basis of sampling and analysis at Study Areas 19, 20 and 21 and both human health and ecological preliminary risk evaluations performed, there is no reason to conclude that possible hazardous waste contamination of groundwater due to the past and present operation of the waste water treatment plant has caused significant environmental contamination or poses a threat to human health or the environment. In surface soil, only cadmium was detected at concentrations representing a potential risk to ecological receptors. The levels and distribution of cadmium in surface soil are attributed to deposition by the Nashua River along its floodplain during periodic floods and are not associated with the waste water treatment plant. A removal action to remediate this potentially large affected area would likely require the harvesting of trees for heavy equipment access, and the associated disruption of the understory and surface soil was perceived to be more detrimental to the floodplain habitat than the presence of contaminants themselves. Further, surface soil would be recontaminated by periodic floods of the Nashua River. Therefore, it is proposed that Study Areas 19, 20 and 21 be removed from further consideration in the Installation Restoration Program process and that any further action be addressed under the applicable waste water regulations and standards.

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## 1.0 INTRODUCTION

This decision document has been prepared to support a No Further Action decision at Study Areas (SAs) 19, 20, and 21, collectively known as the Fort Devens Waste Water Treatment Plant (WWTP). The WWTP is comprised of SA 19 - Imhoff Tanks, SA 20 - Rapid Infiltration Sand Beds, and SA 21 - Sludge Drying Beds. The report was prepared as part of the U.S. Department of Defense (DoD) Base Realignment and Closure (BRAC) program to assess the nature and extent of contamination associated with site operations at Fort Devens.

In conjunction with the Army's Installation Restoration Program (IRP), Fort Devens and the U.S. Army Environmental Center (USAEC; formerly the U.S. Army Toxic and Hazardous Materials Agency) initiated a Master Environmental Plan (MEP) in 1988. The MEP consists of assessments of the environmental status of SAs, specifies necessary investigations, and provides recommendations for response actions with the objective of identifying priorities for environmental restoration at Fort Devens. SAs 19, 20 and 21 were identified as potential sources of contamination in the MEP. On December 21, 1989, Fort Devens was placed on the National Priorities List under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act.

An Enhanced Preliminary Assessment (PA) was also performed at Fort Devens to address areas not normally included in the CERCLA process, but requiring review prior to closure. A final version of the PA report was completed in April 1992. In 1992, DoD, through USAEC, initiated a Site Investigation (SI) for SAs 19, 20 and 21 along with the other eight SAs in SA Groups 3, 5 and 6 at Fort Devens. The SI was conducted by ABB Environmental Services, Inc (ABB-ES).

Under Public Law 101-510, the Defense Base Realignment and Closure Act of 1990, Fort Devens has been selected for cessation of operations and closure. An important aspect of BRAC actions is to determine environmental restoration requirements before property transfer can be considered. Studies at SAs 19, 20 and 21 were conducted to support this overall mission.

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## **2.0 BACKGROUND AND PHYSICAL SETTING**

### **2.1 DESCRIPTION AND LAND USE**

Fort Devens is located approximately 35 miles northwest of Boston, Massachusetts, adjacent to the town of Ayer and within Middlesex and Worcester counties. The installation consists of approximately 9,280 acres and includes portions of the towns of Ayer, Harvard, Lancaster, and Shirley. Cities in the vicinity include Fitchburg, Leominster, and Lowell. Land surfaces range in elevation from about 200 feet (ft) above mean sea level (MSL) along the Nashua River in the northern portion of the installation to 450 ft above MSL in the southern portion of the installation.

Fort Devens was established in 1917 as Camp Devens, a temporary training camp for soldiers from the New England area. In 1931, the camp became a permanent installation and was redesignated as Fort Devens. Throughout its history, Fort Devens has served as a training and induction center for military personnel and a unit mobilization and demobilization site. All or portions of this function occurred during World Wars I and II, the Korean and Vietnam conflicts, and operations Desert Shield and Desert Storm.

The primary mission of Fort Devens is to command, train, and provide logistical support for non-divisional troop units as well as support various tenant activities. The installation also supports that portion of the U.S. Army Intelligence School located at Fort Devens, for the Army Readiness Region, Reserve Components, and Army Reserve and National Guard in the New England area.

Fort Devens currently consists of three major land use areas: Main Post, South Post, and North Post (Figure 2-1).

The majority of the facilities on Fort Devens are located in the Main Post area, north of Massachusetts Highway 2. The Nashua River intersects the Main Post along its western edge. The Main Post provides all of the on-post housing, including over 1,700 family units and 9,800 bachelor units (barracks and unaccompanied officer's quarters). Other facilities on the Main Post include community support activities (such as a cafeteria, post exchange, commissary, bowling alley, and golf course), administrative buildings, classrooms and training facilities, maintenance facilities, and ammunition storage facilities.

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## SECTION 2

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The South Post is located south of Massachusetts Highway 2 and contains individual training areas designated for troop training and range activities, and a parachute drop zone where air training exercises are performed. The Nashua River bounds the South Post on the northeast side.

The North Post abuts the Main Post on the northern side of West Main Street in Ayer, Massachusetts. The principal operations on the North Post are the Douglas E. Moore Army Airfield and the installation WWTP. SAs 19, 20, and 21 are located on the North Post.

### 2.2 REGIONAL GEOLOGY

Fort Devens is near the western boundary of the Seaboard Lowland Section of the New England-Maritime Physiographic province (Jahns, 1953). It is adjacent to the Worcester County Plateau of the Central Uplands province, and part of the installation lies within the province (Koteff, 1966). The land surface is almost completely covered with unconsolidated glacial outwash deposits, resulting in few bedrock outcrops. The surficial deposits are underlain by a highly complex assemblage of intensely folded and faulted metasedimentary rocks with occasional igneous intrusions. The geomorphology of the region is dominated by glacial features such as outwash plains, kames, kame terraces, drumlins, and eskers.

### 2.3 REGIONAL HYDROGEOLOGY

Groundwater at Fort Devens occurs largely in the permeable glacial-deltaic outwash deposits of sand, gravel, and boulders. Well yields within these sediments are dependent upon the hydraulic characteristics of the aquifer and can range from 2 to over 300 gallons per minute (gpm). Small amounts of groundwater can be obtained from fractured bedrock with yields ranging from 2 to 10 gpm. Minor amounts of groundwater may be found in thin, permeable glacial lenses elsewhere on the installation. The primary hydrogeologic feature at Fort Devens is the Nashua River, which flows through the installation in a south-to-north direction with an average discharge rate of 55 cubic feet per second. In addition to the Nashua River, numerous brooks that are associated with attendant wetlands dissect the terrain. There are also several kettle ponds and one kettle lake located within the installation.

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## 2.4 STUDY AREA DESCRIPTION AND HISTORY

The WWTP, constructed west of the Nashua River on the North Post in 1942, is still in operation. It has a design capacity of 3 million gallons per day (MGD), but in 1993 the average annual effluent flow was 0.74 MGD.

Preliminary sewage treatment is conducted at the main pumping station (Figure 2-2) which has a bar screen, grit chamber, and comminutor. Following preliminary treatment, the effluent is pumped to the three parallel Imhoff tanks located at the top of a kame terrace adjacent to the rapid infiltration sand beds. Settleable solids are anaerobically digested in the lower compartments of the tanks, and digestive gases are vented to the atmosphere. Clarified wastewater is discharged into a dosing tank, which intermittently applies this unchlorinated primary effluent to varying combinations of the 22 rapid infiltration basins (Biang et al., 1992; Dzuray, 1992; and McMaster et al., 1982).

Settled solids (typically 4 to 10 percent solids) from the Imhoff tanks are drained two or three times a year to sludge drying beds, and supernatant from the sludge is collected in a clay underdrain system. Prior to 1982, the supernatant was discharged at the surface to the adjacent Nashua River forested floodplain. As used in this report, the forested floodplain refers to an area of drier mixed mesophytic woods in the 100 year floodplain of the Nashua River, as well as those areas containing palustrine bordering vegetated wetland. Since 1982 the supernatant has been collected in a sump and pumped back to the rapid infiltration basins.

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### **3.0 RELATED INVESTIGATIONS**

#### **3.1 MASTER ENVIRONMENTAL PLAN**

After a review of WWTP records and associated files, the MEP identified no contaminant problems with the WWTP Imhoff tanks (SA 19). Thus, no proposed actions were recommended for this portion of the WWTP.

The rapid infiltration sand beds (SA 20) were identified as a possible source for the release of contaminants to the environment. The MEP specifically identified elevated nitrate concentrations in groundwater downgradient of SA 20 as a contaminant concern. It was recommended that the existing groundwater monitoring well network around the WWTP be resampled for a full suite of contaminant analytes. Additional recommendations in the MEP included investigation of surface water and sediment in the Nashua River at locations upstream and downstream of the facility.

The sludge drying beds (SA 21) were also identified as a possible source of downgradient groundwater contamination. Sludge samples collected from the bottoms of the Imhoff tanks (considered representative of the sludge that is periodically discharged to the drying beds) contained elevated concentrations of several inorganic analytes, including cadmium and selenium in excess of maximum allowable concentrations of Massachusetts Type I sludge. Given these results, the MEP recommended sampling surface water, sediment, and groundwater in conjunction with the sampling planned for SA 20. Because of the potential for surficial contaminant releases from the sludge drying beds, the MEP additionally recommended that surface soil be collected from the adjacent floodplain area and analyzed for a full suite of contaminant analytes.

#### **3.2 ENHANCED PRELIMINARY ASSESSMENT**

The PA included a review of the studies and recommendations presented in the MEP, and consideration of other areas that might require evaluation due to the closure of Fort Devens. No additional hazardous waste findings or recommendations for SAs 19, 20 and 21 were provided in the PA.

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### 3.3 SITE INVESTIGATION AND SUPPLEMENTAL SITE INVESTIGATIONS

The SI was initiated in June 1992 and included eleven of the Group 3, 5 and 6 SAs listed in the MEP, including SAs 19, 20, and 21:

- SA 38 (Building 3713/Battery Repair Area)
- SA 44 (Cannibalization Yard)
- SA 52 (TDA Maintenance Yard)
- SA 09 (North Post Landfill)
- SA 19 (Waste Water Treatment Plant - Imhoff Tanks)
- SA 20 (Rapid Infiltration Sand Beds)
- SA 21 (Sludge Drying Beds)
- SA 30 (Moore Army Airfield Drum Storage Area)
- SA 31 (Moore Army Airfield Fire-Fighting Training Area)
- SA 47 (Moore Army Airfield Underground Storage Tank Site)
- SA 50 (Moore Army Airfield World War II Fuel Point)

The SI was conducted by ABB-ES under contract with the USAEC. The purpose of the SI was to verify the presence or absence of environmental contamination and to determine whether further investigation or remediation was warranted. The Final SI Report for Groups 3, 5, and 6 was issued in April 1993 (ABB-ES, 1993a). A subsequent investigation (Supplemental Site Investigation [SSI]) was conducted by ABB-ES to further characterize the extent of soil contamination identified at SA 21. The results of this supplemental investigation were reported in the SSI Data Package issued in September 1993 (ABB-ES, 1993b).

Investigations conducted in the vicinity of SAs 19, 20, and 21 were designed to determine whether the WWTP as a whole is discharging hazardous materials to the environment, and to identify the range of influence of sanitary sewage discharges in the area. Water-level measurements and the resulting potentiometric surface map indicate that the wastewater infiltration beds and the large kame-plain remnant on which they are located have little apparent influence on groundwater flow. Generally, groundwater flows eastward beneath the WWTP to the Nashua River (Figure 3-1).

Groundwater was sampled in the 16 existing U.S. Army Environmental Hygiene Agency (AEHA) wells installed around the WWTP and in three new monitoring wells installed (as part of the SA 09 SI) near the WWTP. Surface water and sediment were sampled at 10 locations in the Nashua River, Walker Brook, and a

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pond north of the WWTP. Twelve surface soil (0 to 2 feet deep) and two subsurface soil (2 to 4 feet deep) samples were collected from the floodplain at the former supernatant discharge pipe. Groundwater samples were analyzed for Project Analyte List (PAL) organic compounds, PAL inorganic analytes, PAL anions and cations, total petroleum hydrocarbon compounds (TPHC), PAL explosives, total suspended solids (TSS), PAL water quality parameters, and total- and fecal-coliform bacteria. Surface water and sediment samples were analyzed for PAL organic compounds, PAL inorganic analytes, PAL explosives, and TPHC to assess the impacts of groundwater discharging to the Nashua River. Surface soil samples were analyzed for PAL organic compounds, PAL inorganic analytes, TPHC, and total organic carbon (TOC) to assess potential releases from the sludge drying beds. Analysis results are presented and evaluated in Section 4.0.

To further characterize the lateral extent of contaminant migration downslope of the discharge pipe, additional supplemental sampling activities for SA 21 were proposed at the March 31, 1995 Base Closure Team (BCT) meeting. Three additional surface-soil and two sediment samples were subsequently collected on April 11, 1995 and submitted for laboratory analysis of PAL inorganics. Analytical results are presented in Section 4.0 and Appendix A.

### 3.4 PRELIMINARY RISK EVALUATION

Preliminary Risk Evaluations (PREs) were performed as part of the SI/SSI to help establish whether environmental contamination at the WWTP required further investigation or remediation. The Ecological PRE was revised in June 1995, using data from the five additional sampling points to re-evaluate the impact of detected inorganic analytes on ecological receptors. This section presents the general approach employed for the SI PREs; details of the human health and ecological PREs for SAs 19, 20 and 21 are presented in Sections 5.0, and 6.0, respectively.

As presented in Section 3.3, environmental investigations at the WWTP entailed sampling and analysis of the following environmental media:

- Groundwater
- Surface Water and Sediments
- Surface Soil (defined as soil to a depth of 3 feet)
- Subsurface Soil (defined as soil between 3 and 15 feet)

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The laboratory results compiled for surface and subsurface soil were used in both the human health and ecological PREs; the human health PRE also considered contamination in groundwater. Because analytes detected in the Nashua River are not derived specifically from the Groups 3, 5, and 6 SAs, the Army and regulatory authorities have previously agreed to evaluate surface water and sediment from these water bodies in a separate study (Area Requiring Environmental Evaluation [AREE] 70) and not to consider them in the SAs 19, 20 and 21 PREs. The AREE 70 study determined that metals and semivolatile organic analytes detected in sediments and surface water collected from the northern section of the Nashua River were at low concentrations and did not show any significant trends. Due to the limited nature and extent of contamination in the northern section of the Nashua River, no further action was recommended in the AREE 70 report (ADL, 1994).

### 3.4.1 Human Health Risk Evaluation

The Human Health PRE at SAs 19, 20 and 21 included the following elements:

- **Current and Future Land Use:** Current and foreseeable future land uses are particularly relevant with respect to the applicability of soil screening values used in the PRE. Two sets of soil screening values were used in the evaluation. One set, U.S. Environmental Protection Agency (USEPA) Region III risk-based concentrations for residential soil, was used when the current and/or foreseeable future land use is residential. The other set, USEPA Region III risk-based concentrations for commercial/industrial soil, was used when the current and/or foreseeable future land use is commercial or industrial.
- **Comparison to Public Health Standards and Guidelines:** For soil and groundwater, human health standards and/or guidelines were used as screening criteria to evaluate the significance of the sampling data. To evaluate the concentrations of compounds detected in groundwater, federal and Massachusetts drinking water standards and guidelines were used. The USEPA's Region III risk-based concentrations were used to evaluate the results of the soil sampling program. The basis and applicability of these standards and guidelines are discussed below.

**USEPA Drinking Water Regulations.** Federal drinking water standards (both final and proposed) were used to evaluate the significance of the

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groundwater sampling data. These standards were extracted at the time of the SI from the USEPA Office of Water's "Drinking Water Regulations and Health Advisories", November 1992.

**Massachusetts Drinking Water Standards and Guidelines.** For some compounds, Massachusetts Department of Environmental Protection (MADEP) has promulgated drinking water standards that are more stringent than the federal drinking water standards. MADEP has also developed drinking water guidelines for compounds for which no federal standards exist.

**OSWER Lead Guidance (OSWER Directive: 9355.4-02).** USEPA has set forth an interim soil cleanup level for total lead which is protective for direct contact exposure at residential settings. The interim guidance was published in September 1988. Further guidance will be developed after the USEPA has developed a verified Cancer Potency Factor and/or a Reference Dose for lead.

**USEPA Region III Risk-Based Concentration Table.** This table is used by USEPA Region III toxicologists as a risk-based screening tool for Superfund sites, a benchmark for evaluating preliminary site investigation data, and preliminary remediation goals. Although it has no official status either as regulation or guidance, it is useful as a screening tool. The table is updated quarterly and therefore regularly incorporates new USEPA toxicity constants as they are developed. During the production of the SI Report (April 1993), the First Quarter update (USEPA, 1993a) was used in the PRE. During the Supplemental Site Investigation (SSI) soils data evaluation, the Third Quarter 1993 (USEPA, 1993b) update was used in the human health PRE.

For the SAs 19, 20 and 21 Human Health PRE, Region III risk-based concentrations for tap water and residential soil were used. Risk-based concentrations for tap water assume daily consumption of two liters of water for a residential lifetime of 30 years; these also assume exposure from the inhalation of volatiles from household water uses (including showering, laundering, and dish washing). Risk-based concentrations for residential soil assume that an individual ingests soil 350 days per year for a residential lifetime of 30 years, at an age-adjusted ingestion rate of 100 milligrams per day.

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### 3.4.2 Ecological Risk Evaluations

The ecological PRE at SAs 19, 20 and 21 included the following elements:

- **Ecological Characterization:** The purpose of the ecological characterization was to identify ecological receptors potentially exposed to contamination at the SA. For part of the research being conducted for the U.S. Army Corps of Engineers, ABB-ES has developed a database of all flora and fauna known to occur seasonally or permanently at, or migrate through, Fort Devens (ABB-ES, 1992). Particular emphasis has been paid to rare and endangered biota. The term "rare and endangered" is used to refer to those species with protected status under the Federal Endangered Species Act of 1973, as amended in 1988, and the Massachusetts Endangered Species Act of 1990. The most current versions of both state and federal rare and endangered species lists have been included in this Fort Devens Biological Database. Information regarding all rare and endangered species known to occur at Fort Devens has been obtained from the Massachusetts Natural Heritage Program (MNHP) and the U.S. Fish and Wildlife Service. In addition, the ABB-ES database contains records that have not yet been incorporated into the MNHP database. This database was used to ascertain whether or not the WWTP is providing habitat for rare and endangered species.
- **Comparison to Ecological Standards and Criteria:** This element of the ecological PRE identified possible ecological exposure pathways and served to characterize the risk to terrestrial and aquatic receptors potentially exposed to environmental contamination at the SA.

Exposure pathways describe the mechanism(s) by which ecological receptors are exposed to contaminated media, and consist of: (1) a contaminant source; (2) an environmental transport medium; (3) a point of receptor contact; and (4) the exposure route (e.g., ingestion of prey items that have bioaccumulated contaminants in their tissues, drinking of contaminated surface water, incidental sediment ingestion, dermal absorption, inhalation, etc.). Potential receptors at the WWTP include terrestrial biota in uplands and semi-terrestrial biota in palustrine wetland (i.e., wetland wildlife).

No state or federal standards or guidelines exist for surface soil exposure, so it was evaluated through comparison of maximum analyte concentrations in surface soils to protective contaminant levels (PCLs) obtained through a

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computer-generated chronic exposure food web model. In order to establish conservative PCLs for the screening level PRE, an acceptable level of risk (Hazard Index [HI] equals 1) associated with chronic exposure to each surface soil contaminant isolated at Fort Devens was established. The food model is further described in the SI Report (ABB-ES, 1993a). The surface soil PCLs are referred to as benchmark values.

Screening of ecological risk at the WWTP was based on establishing a contaminant-specific ratio between the maximum exposure concentrations and the benchmark values. This comparison of the exposure concentration with the appropriate benchmark results in an index of potential impact associated with exposure to environmental contaminants. When the maximum exposure concentration was less than the benchmark value (i.e., the ratio of the exposure concentration to the benchmark value  $< 1$ ), ecological risk was assumed to be insignificant. When the value exceeded the exposure concentration (i.e., the ratio of the exposure concentration to the benchmark value  $> 1$ ), a discussion of the ecological significance of this exceedance was included in the PRE. This conservative approach provided a screening-level evaluation of potential effects of individual chemicals of potential concern (CPCs) on ecological receptors.

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## 4.0 CONTAMINANT ASSESSMENT

Samples collected in the SA 19, 20 and 21 Site Investigation and Supplemental Site Investigation were analyzed for PAL organic compounds, inorganic analytes, explosives, TPHC, and water quality parameters, as well as coliform bacteria and anions/cations (groundwater only), because of the wide variety of potential contaminants associated with the WWTP. The raw laboratory analytical results from samples collected in SAs 19, 20 and 21 and in the SA Group 5 area are included in Appendices L and N of the SI Report (ABB-ES, 1993a) and the SSI Data Package (ABB-ES, 1993b). Samples collected during the April 11, 1995 sampling event were submitted for PAL inorganics analysis. Analytical results from these five additional sampling locations are summarized in a letter included herein as Appendix A. All analytical results are discussed by medium in the following subsections.

### 4.1 GROUNDWATER

Nineteen monitoring wells surrounding the WWTP were sampled as part of the Group 5 SI. Seven of those wells, located immediately downgradient of the WWTP, were selected specifically to evaluate impacts to groundwater due to releases from the infiltration beds and sludge-drying beds (WWTMW-01A, WWTMW-02, WWTMW-02A, WWTMW-03, WWTMW-04, WWTMW-09, and WWTMW-10; see Figure 4-1). Wells WWTMW-11, WWTMW-12, WWTMW-13, and WWTMW-14 are located on the east side of the Nashua River (across a hydrologic divide). Groundwater at these locations is not influenced by SAs 19, 20, and 21.

Three rounds of groundwater sampling were conducted for volatile organic compounds (VOCs), because the Round 2 samples were suspected of being cross contaminated with VOCs during that sampling event. The third round of sampling for VOCs was conducted to replace the rejected Round 2 results. (A complete discussion of the cross contamination problem is provided in Section 3.2.3 of the SI Report; ABB-ES, 1993a). The combined Round 2 and 3 sampling results are hereafter referred to as Round 2/3.

With the exception of bis(2-ethylhexyl)phthalate (B2EHP), a suspected laboratory contaminant (see discussion in Section 4.4), organic compounds were detected in

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WWTMW-02 and WWTMW-02A only. During all sampling rounds, groundwater from WWTMW-02 contained the greatest number and highest concentrations of organic compounds. WWTMW-02 is closest to, and downgradient from, the sludge drying beds. Organic compounds detected in groundwater included acetone, carbon tetrachloride, 1,1,1-trichloroethane (TCA), chloroform, and trichloroethylene (TCE) in WWTMW-02. Only toluene was detected in groundwater at WWTMW-02A during Round 1 sampling; it was not detected at this location during Round 3 sampling. At the concentration detected in Round 1, toluene is likely attributable to laboratory contamination (see Section 4.4). Total coliform bacteria counts were detected at all well locations except WWTMW-04 during the two sampling rounds. No fecal coliform was detected in any of the SA Group 5 wells. TPHC were not detected in any of the seven selected downgradient wells. Tables 4-1 and 4-2 list detected organic compounds in all SA Group 5 groundwater samples. Figures 4-2 and 4-3 show the distribution of organic compounds and coliform bacteria in groundwater.

The source of the chlorinated solvents detected in the lone monitoring well WWTMW-02 has been in question since the Round 1 groundwater sampling. The compounds of concern include TCE, TCA, and carbon tetrachloride. Information gathered from another groundwater study currently being conducted by AEHA shows that the isolated appearance of TCE, the most prevalent chlorinated solvent compound, is consistent with the May 1991 installation of a replacement Hypalon liner for the sludge drying beds (Table 4-3). The solvent used to weld the liner material together consisted of 80 percent TCE. The appearance of TCE in the nearest downgradient well and the correlation between the composition of the solvent and the timing of the liner installation suggest that the contamination was released during liner installation. TCE concentrations declined with time with the highest concentration (61 micrograms per liter [ $\mu\text{g/l}$ ]) detected on July 9, 1991, and the most recent concentration of 3.5  $\mu\text{g/l}$  detected on August 19, 1993. The other compounds detected in Round 1 (TCA and carbon tetrachloride) were not detected in the AEHA samples, but they decreased in concentration in ABB-ES' samples between Round 1 and Round 3, to concentrations in Round 3 that were near the detection limits for each. TCA was detected in water method blank samples at similar concentrations and is, therefore, considered a potential laboratory contaminant (see Section 4.4).

One or more inorganic analytes were detected above calculated Fort Devens background levels in virtually all groundwater samples collected from SA Group 5 monitoring wells during both rounds of sampling. The highest concentrations of

these inorganic analytes were observed in monitoring wells located nearest the WWTP (in WWTMW-02 and WWTMW-02A). However, filtered groundwater samples collected from Group 5 wells during Round 2 sampling indicate that much of the elevated concentrations are due to suspended solids in the groundwater samples.

Elevated concentrations of nitrate/nitrite, detected in monitoring wells located immediately downgradient of the WWTP in both rounds of sampling, are likely attributable to the continued operation of the sand infiltration beds. A trace concentration of 2,4-dinitrotoluene was detected in WWTMW-02 during Round 1 sampling. The compound was not detected in Round 2. The source of 2,4-dinitrotoluene detected in the Round 1 groundwater sample from WWTMW-02 is not clear, but may be the result of historical supernatant releases beneath the sludge drying beds. Tables 4-4 and 4-5 list the inorganic analytes detected in SA Group 5 groundwater samples. Figures 4-4 and 4-5 show the distribution of inorganic analytes detected in SA Group 5 groundwater samples.

## 4.2 SURFACE WATER AND SEDIMENT

Surface water and sediment samples were collected as part of the SI at nine locations along the Nashua River and at one location in the small pond located to the north of the WWTP. On April 11, 1995 two additional sediment samples were collected in the Nashua River floodplain downslope of the former supernatant discharge pipe. The analytical results are discussed in the following paragraphs. The results of surface water and sediment analyses are provided in Tables 4-6 and 4-7, and are illustrated on Figures 4-6, 4-7, 4-8, and 4-9. Refer also to Appendix A.

Organic compounds were detected in two Nashua River surface water samples and the pond. The detected analytes include low concentrations of B2EHP, carbon disulfide, toluene, and TCA. No clear distribution of these analytes is apparent. B2EHP, toluene, and TCA were detected in laboratory method blanks at similar concentrations and are thus considered potential laboratory contaminants (see Section 4.4). The source of carbon disulfide in surface water at G5D-92-10X collected from the pond located north of the WWTP is not known, but does not appear to be connected to the WWTP because the compound was not detected at any other location in any other medium in samples collected in this SA.

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Total and fecal coliform bacteria counts generally increased at downstream locations. The highest counts were observed at G5D-92-07X, G5D-92-08X, and G5D-92-09X. Figure 4-6 shows the distribution of organic compounds and coliform bacteria detected in Group 5 surface water samples.

Inorganic analyte concentrations were relatively consistent when comparing upstream and downstream Nashua River surface water samples. These concentrations are likely representative of typical Nashua River surface water. The distribution of selected inorganic analytes are provided in Figure 4-7.

For organic compounds in sediment, both VOCs and semivolatile organic compounds (SVOCs) were detected in the Nashua River and nearby pond. Concentrations of these analytes (acetone, toluene, and several polynuclear aromatic hydrocarbons) were generally low, and no consistent distribution along the river is apparent. Acetone and toluene were detected in soil method blanks at similar concentrations and are considered to be potential laboratory contaminants (see Section 4.4). TPHC were detected in sediment samples in a similar sporadic distribution, but no significant correlation between VOCs, SVOCs, and TPHC is evident. Figure 4-8 shows the distribution of organic compounds detected in Group 5 SA sediments.

Inorganic analyte concentrations were relatively consistent in upstream and downstream Nashua River sediment samples. These concentrations are likely representative of typical Nashua River sediments. The highest concentrations of cadmium, chromium, and lead detected in sediment (and surface-soil) samples collected at SA 21 are similar to the concentrations detected in sediment samples collected from the Nashua River near SA 21. It is inferred that cadmium, chromium, and lead concentrations at SA 21 are attributable to flood deposits of the Nashua River. The distributions of selected inorganic analytes are provided in Figure 4-9 and in Appendix A.

It has been inferred that contaminants detected in Nashua River surface water and sediment samples collected during the Group 5 SI are not directly attributable to any particular source at the WWTP. The Army has addressed these contaminant issues in a comprehensive storm-water runoff study (ADL, 1994).

### 4.3 SURFACE SOILS

During the initial SI, surface soil samples were collected at the former outfall pipe (21S-92-01X), and roughly 5 feet downslope (21S-92-02X). No VOCs or SVOCs were detected in these samples. TPHC were detected in both samples at roughly the same concentrations, 1,310 micrograms per gram ( $\mu\text{g/g}$ ) and 1,490  $\mu\text{g/g}$  for 21S-92-01X and 21S-92-02X, respectively. Numerous inorganic analytes were detected at concentrations above the calculated background concentrations for Fort Devens soils. Inorganic analytes that were significantly higher than background (greater than one order of magnitude) included: barium, copper, mercury, silver, and zinc. No significant trends in concentration values were apparent between the sample nearest and the sample farthest from the supernatant outfall pipe.

Given the types and concentrations of contaminants detected in surface soils downslope of the sludge drying beds, it was determined that insufficient data had been collected during the initial SI to fully evaluate contaminant conditions. Additional soil sampling was deemed necessary to further characterize the distribution of observed contaminants and provide for the evaluation of risk to human health and ecological receptors. This SSI included sampling both surface soils radially away from the discharge pipe to evaluate the extent of contaminant migration and subsurface soil to assess potential downward migration.

Using the same sampling methodology used to collect the initial surface soil samples, a total of 10 surface soil and two subsurface soil samples were collected during the SSI from the area downslope of the former sludge drying beds discharge pipe. Surface sample locations were selected from low-lying areas within an approximate 80 foot radius from the discharge pipe down slope where surface water discharge was presumed to have ponded historically. Figure 4-10 shows the surveyed locations of the 12 surface soil samples collected during the SA 21 SI/SSI. The locations of the two subsurface soil samples collected are shown in Figure 4-11. Samples were collected from immediately beneath an organic layer (mostly pine needles) and predominantly consisted of silty sands. Subsurface soil samples were collected by hand (using a shovel and post hole digger) from the zone approximately 2 to 4 feet below grade in the area closest to the discharge pipe where concentrations are presumed to be the highest. All collected samples were submitted for laboratory analysis of inorganic analytes and TPHC.

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All surface soil samples collected during the SI and SSI exhibited inorganic analyte concentrations in excess of calculated background concentrations. The highest concentrations (those exceeding background by one order of magnitude) included barium, copper, mercury, silver, and zinc (Table 4-8). The highest concentrations of these analytes were detected in the two samples collected nearest the discharge pipe (21S-92-01X and 21S-92-02X) during the SI and the samples collected at 21S-93-07X, -08X, 09X, -10X, and -12X during the SSI (Figure 4-12). Some inorganic analytes (e.g., chromium, arsenic, and lead) were also detected at concentrations above background concentrations, but were not as elevated as copper, mercury, and silver. TPHC were detected in all surface soil samples collected with concentrations ranging from 98  $\mu\text{g/g}$  to 1,490  $\mu\text{g/g}$ .

Subsurface soil samples collected from 2 to 4 feet below the surface exhibited markedly lower concentrations of inorganic analytes than the corresponding surface soil samples. Only beryllium, copper, nickel, sodium, and zinc were detected (marginally in most cases) above the calculated Fort Devens background concentrations for these analytes. TPHC were not detected in either subsurface sample. Concentrations of inorganic analytes detected above background are slightly higher in the sample located closest to the discharge pipe (Figure 4-13).

The distribution of inorganic analytes and TPHC in soils located adjacent to the sludge drying beds suggests that the former supernatant discharge pipe was a likely source of inorganic contaminants detected in surface soils. The highest concentrations of some inorganic analytes (copper, mercury, and silver) were observed in a radiating pattern leading from the discharge pipe as roughly shown in Figure 4-14. These analytes are typical of sanitary sewage. Other inorganic analytes (such as chromium, arsenic, and lead), which were detected above background, did not follow the same distribution pattern, appearing ubiquitously in SA 21 surface soils. TPHC were detected in a similar ubiquitous pattern in surface samples as well.

The SI and SSI data suggest that supernatant originating from the discharge pipe spread inorganic contaminants laterally down slope with flow of supernatant and concentrated certain contaminants (copper, mercury, and silver) in a 1,500 square foot low-lying area where it likely ponded. Other inorganic analytes were detected at elevated concentrations, but appear to be distributed homogeneously in the sampling area and not limited to the area downslope of the discharge pipe. Concentrations of some analytes such as arsenic, chromium, and TPHC are likely naturally elevated in this floodplain environment. The absence of organic

constituents (from the PAL VOCs and SVOCs) in the samples suggests that TPHC may be derived from natural organic matter observed at the surface (pine needles). A comparison of surface and subsurface soil contaminant concentrations suggests that significant downward contaminant migration has not occurred.

Analytical results from the April 11, 1995 sampling event are consistent with the findings of the SI and the SSI. Several compounds (copper, mercury, silver, and barium) detected in these surface soil samples were identified as being directly related to discharge from the former supernatant pipe. Other inorganic analytes (cadmium, chromium, and lead) detected in surface soil (and sediment) exhibit a distribution pattern which mimics topography and is unrelated to the former supernatant pipe. These concentrations are similar in magnitude to concentrations detected in Nashua River sediments collected near SA 21 and are assumed to be attributable to Nashua River contamination.

#### 4.4 QUALITY CONTROL BLANKS

The quality control blanks analyzed during the Groups 3, 5 and 6 SI included method blanks, trip blanks and rinsate blanks. Method blanks were analyzed to determine if compound analytes were introduced at the laboratory. Data were generated by Environmental Science and Engineering, Inc. (ESE) laboratories from soil and water samples collected from May through July 1992.

Method blanks were analyzed for organic contaminants and used as quality control samples for the evaluation of SAs 19, 20 and 21 analytical samples. Chemically pure deionized water was used to prepare method blanks at the laboratory. The blanks were run as if they were actual field samples using methods LM19 and UM20 for VOCs in soil and water, respectively; and methods LM18 and UM18 for SVOCs in soil and water, respectively. Because water used in the preparation of the blanks was contaminant free, any detected compounds were considered to be the result of laboratory contamination. Because method blanks were prepared and analyzed periodically throughout the Groups 3, 5 and 6 SI sample analysis program, there is no logical way to assign individual blanks to any specific group. Therefore, the results for method blank contamination are applied globally for all of SA Groups 3, 5 and 6. The following data is a presentation of all organic compounds detected above detection limits in the SA Groups 3, 5 and 6 method blanks and the frequency at which they were found.

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Water method blanks contained the following PAL organic compounds: B2EHP (two of two samples at 6.6 micrograms per liter [ $\mu\text{g/l}$ ]), toluene (four of 36 samples at 0.5 to 0.51  $\mu\text{g/l}$ ), chloroform (16 of 36 samples at 0.5 to 1.3  $\mu\text{g/l}$ ), TCA (six of 36 samples at 1.1 to 2.5  $\mu\text{g/l}$ ).

Soil method blanks contained the following PAL organic compounds: toluene (two of two samples at 0.2  $\mu\text{g/g}$ ), B2EHP (two of 26 samples at 1.1  $\mu\text{g/g}$ ), acetone (two of 48 samples at 0.036  $\mu\text{g/g}$ ), trichlorofluoromethane (TCFM) (four of 48 samples at 0.008  $\mu\text{g/g}$ ), and chloroform (two of 48 samples at 0.002  $\mu\text{g/g}$ ).

B2EHP, detected in laboratory blanks, is listed in the USEPA Statement of Work (SOW) as a common laboratory contaminant and when detected in sample results at similar concentrations is probably representative of laboratory contamination. Other SVOCs detected in soil and water method blanks were 1,2-epoxycyclohexene, mesityl oxide, and several unknown compounds. These non-target compounds should also be considered as laboratory contaminants when seen in sample data at similar concentrations.

Toluene, acetone, TCFM, chloroform and one unknown compound were detected in the soil method blanks. Toluene, acetone and chloroform are defined as common laboratory contaminants in the USEPA SOW. TCFM, although not included in this list, is also used frequently as a solvent in laboratories. These compounds can be considered as laboratory introductions when observed in similar concentrations to those in the method blank data.

TCA, toluene, and chloroform were reported in the water method blanks. As stated previously, toluene and chloroform are common laboratory contaminants. Their presence in similar concentrations as sample results should be attributed to this introduction rather than site contamination. The presence of TCA has also been attributed to laboratory contamination per conversations with ESE Laboratory personnel. The problem was persistent for several months.



## 5.0 PRELIMINARY HUMAN HEALTH RISK EVALUATION

The WWTP has operated since 1942 and is expected to continue operation for the foreseeable future.

Tables 5-1 and 5-2 present summary statistics and human health standards and guidelines used in the PRE for SAs 19, 20 and 21. Average values presented in the following discussions reflect the average concentration of all samples collected. By convention, where a concentration is below the laboratory detection limit, one half the detection limit concentration is used in the calculation.

### 5.1 GROUNDWATER

Nineteen monitoring well locations have been used to define the groundwater quality in the vicinity of the WWTP. Monitoring well locations WWTMW-01A, 02, 02A, 03, 04, 09, and 10 are directly downgradient of the WWTP. Table 5-1 presents summary statistics for unfiltered samples collected from these wells and drinking water standards and guidelines for comparison.

The maximum detected concentration of most of the inorganic analytes exceed the statistical background concentrations.

There is a clear correlation between insoluble inorganic analytes (e.g., arsenic, copper, lead, nickel, zinc) levels and TSS. However, the number of analytes exceeding the statistical background concentrations cannot be explained fully by TSS levels. It must be concluded that the WWTP has affected groundwater quality immediately downgradient of the sand infiltration beds.

The maximum detected concentrations of six inorganic analytes in Table 5-1 exceed their respective drinking water standards or guidelines. The exceedances for three analytes -- aluminum, iron, and manganese -- involve secondary Maximum Contaminants Levels; these are federal standards promulgated for aesthetic or economic reasons, not health reasons. The maximum concentrations of aluminum and manganese are well below their respective USEPA Region III tap water concentrations. (No Region III tap water concentration exists for iron.) While the maximum detected concentration of arsenic exceeds the Massachusetts drinking water standard ( $50 \mu\text{g/l}$ ), this occurs in only two of 14 downgradient

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samples (two sampling rounds from seven wells). The average concentration of arsenic in the downgradient wells is  $20 \mu\text{g/l}$ . The maximum detected concentration of cadmium ( $14.9 \mu\text{g/l}$ ) also exceeds the Massachusetts drinking water standards ( $5 \mu\text{g/l}$ ). Cadmium was only detected in three of 14 groundwater samples collected (in two rounds). The average downgradient concentration of cadmium is  $4 \mu\text{g/l}$ . Sodium was detected in excess of the Massachusetts drinking water guideline ( $28,400 \mu\text{g/l}$ ) in roughly half of the samples collected from the downgradient wells. The average concentration of sodium in downgradient wells is  $29,500 \mu\text{g/l}$ , slightly exceeding the guideline.

The only significantly detected organic compound in downgradient WWTP groundwater in Round 1 were the VOCs at monitoring well location WWTMW-02. However, the state and federal primary drinking water standards for all organic compounds, with the exception of TCE ( $5 \mu\text{g/l}$  standard,  $14 \mu\text{g/l}$  maximum) at location WWTMW-02, were not exceeded in any groundwater sample from the WWTP wells.

In Round 2/3, two organic analytes were detected at concentrations above their respective drinking water standards or guidelines. B2EHP was detected at four downgradient locations in exceedance of the USEPA Region III tap water concentration. TCE was detected at one monitoring well at concentrations above the Massachusetts drinking water standard. The average concentrations of TCE and B2EHP across Rounds 1 and 2/3, in seven downgradient wells, are  $2.5$  and  $6.6 \mu\text{g/l}$ , respectively; these averages approximate or are below the respective drinking water standards or guidelines.

The only anions/cations for which a health risk-based guideline exists is nitrate/nitrite. The Region III tap water value of  $58,000 \mu\text{g/l}$  was not exceeded at any WWTP groundwater sampling location. However, the state and federal primary drinking water standard of  $10,000 \mu\text{g/l}$  was exceeded at four of the seven immediately downgradient wells.

One explosive compound (2,4-dinitrotoluene) was detected in the downgradient monitoring wells. It was detected in WWTMW-02 at a concentration of  $0.131 \mu\text{g/l}$  in Round 1. This concentration is below the USEPA Region III tap water concentration of  $73 \mu\text{g/l}$ .

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## 5.2 SURFACE SOIL

This PRE considers all soils to a depth of 3 feet as accessible under a residential future use exposure scenario. This assumption is conservative (i.e., health-protective) because, as discussed above, the expected future use of the WWTP is the continued use of the associated facilities.

Table 5-2 presents summary statistics on surface soil at the WWTP and USEPA Region III residential soil concentrations for comparison. Surface soil downslope of the sludge drying beds is represented by samples 21S-92-01X, 21S-92-02X, 21S-93-03X through -12X, 21B-93-01X, and 21B-93-02X collected from the former supernatant discharge area.

When comparing the SA inorganic compounds in the 14 soil samples to the USEPA Region III residential soil concentrations, three analytes exceeded these concentrations: arsenic detected in 15 of 15 samples (maximum concentration:  $53 \mu\text{g/g}$ ; Region III residential concentration:  $0.97 \mu\text{g/g}$ ), beryllium detected in 12 of 15 samples (maximum concentration:  $2.57 \mu\text{g/g}$ ; Region III residential concentration:  $0.28 \mu\text{g/g}$ ), and manganese detected in 15 of 15 samples (maximum concentration  $708 \mu\text{g/g}$ ; Region III residential soil concentration:  $390 \mu\text{g/g}$ ). Arsenic was detected above the detection limit in 15 of 15 samples. The average arsenic concentration ( $27.4 \mu\text{g/g}$ ) is slightly above the installation-wide calculated background concentration of  $21.1 \mu\text{g/g}$ . The average beryllium concentration ( $1.86 \mu\text{g/g}$ ) is above the installation-wide calculated background concentration of  $0.347 \mu\text{g/g}$ . The average manganese concentration ( $373 \mu\text{g/g}$ ) exceeds the background concentration of  $300 \mu\text{g/g}$ , but is below the Region III residential soil concentration.

Surface soil samples 21S-92-01X and 21S-92-02X were analyzed for VOCs and SVOCs. All results were below the detection limits. Although TPHC were detected in surface soil (maximum  $1490 \mu\text{g/g}$ ; average  $564 \mu\text{g/g}$ ), the absence of organic constituents (from the PAL VOCs and SVOCs) in the samples suggest that it is not associated with the sludge drying beds.

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## 6.0 PRELIMINARY ECOLOGICAL RISK EVALUATION

The purpose of this PRE at the WWTP is to provide a screening-level evaluation of actual and potential risks that environmental contaminants may pose to the resident and migratory ecological receptors at the site.

A mowed grassy area surrounds the sludge drying beds; this region slopes to the east toward the forested floodplain of the Nashua River. Dominant trees in the floodplain include red maple (*Acer rubrum*), American elm (*Ulmus americana*), and white pine (*Pinus strobus*). Other trees observed include pitch pine (*Pinus rigida*), black cherry (*Prunus serotina*), white oak (*Quercus alba*), European buckthorn (*Rhamnus frangula*), and white birch (*Betula papyrifera*). The open understory of the forested floodplain adjacent to the sludge drying beds includes cinnamon fern (*Osmunda cinnamomea*) and Japanese knotweed (*Polygonum cuspidatum*). The floodplain likely provides cover and foraging habitat for a variety of wetlands and semi-terrestrial wildlife, including passerine songbirds, mammals such as the raccoon (*Procyon lotor*) or mink (*Mustela vison*), amphibians (such as the green frog [*Rana clamitans*]), reptiles such as the garter snake (*Thamnophis sirtalis*) and turtle species, and a variety of invertebrates.

No records exist documenting the current or historical presence of rare and endangered species in the region of the WWTP. Although the largest known population of Blanding's turtles in New England is located in the vicinity of Fort Devens (Butler, 1992), the status of this population has been well documented and none are known to occur at the WWTP.

Petroleum hydrocarbons and 17 inorganic contaminants were identified at the 14 surface and subsurface soil sample locations in the vicinity of the sludge drying beds. These samples were collected during the SI and SSI in the Nashua River floodplain adjacent to the sludge drying beds. Aluminum, arsenic, barium, beryllium, cadmium, chromium, copper, lead, manganese, mercury, nickel, silver, vanadium, and zinc were detected during the SI and SSI at maximum levels exceeding background concentrations and were chosen as CPCs. In addition, cobalt and selenium were considered as CPCs in the absence of any soil background data.

A potential contaminant exposure pathway exists at the sludge drying beds for terrestrial (and wetlands) ecological receptors via incidental ingestion of

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floodplain surface soils and food web exposure. A screening-level evaluation of potential effects from soil exposure was conducted by comparison of the maximum concentrations of CPCs to their respective surface soil benchmark values (PCLs) (Table 6-1).

Results of the initial (January 1995) ecological PRE indicated that the maximum concentrations of aluminum, arsenic, barium, beryllium, cadmium, copper, lead, mercury, selenium, and vanadium exceeded their respective PCLs (Table 6-1). Barium was detected at a maximum concentration of 460 micrograms per kilogram ( $\mu\text{g}/\text{kg}$ ), and copper was detected at a maximum concentration of 429  $\mu\text{g}/\text{kg}$ . These values are approximately an order of magnitude greater than the PCLs established for these two inorganics. Lead and cadmium were detected at maximum concentration of 200 and 9.44  $\mu\text{g}/\text{g}$ , respectively, approximately four to five times their PCLs. Mercury was detected at a maximum concentration of 7.9  $\mu\text{g}/\text{g}$ , more than twice its PCL. Selenium and beryllium were detected at maximum concentrations of 1.42 and 2.57  $\mu\text{g}/\text{g}$ , respectively, approximately three times their PCLs. Maximum concentrations of cadmium (9.44  $\mu\text{g}/\text{g}$ ), aluminum (20,000  $\mu\text{g}/\text{g}$ ), arsenic (53  $\mu\text{g}/\text{g}$ ), and vanadium (36.8  $\mu\text{g}/\text{g}$ ) were also slightly higher than their PCLs. Although silver did not exceed the PCLs generated through the food web model, acute and chronic exposure to silver is known to result in a variety of effects, ranging from mortality to argyria (USEPA, 1980).

Data collected from the five additional sampling points (April 1995) were used to recalculate maximum and average concentration values for each of the inorganic analytes detected. In contrast with the initial PRE, results of the revised (June 1995) ecological PRE indicate that with the exception of cadmium and potentially aluminum, no analytes exceed their respective screening values. Aluminum and cadmium were detected at maximum concentrations of 20,000 mg/kg and 22.7 mg/kg, respectively, and at average concentrations of 10,312 mg/kg and 5.4 mg/kg, respectively. When the maximum concentration is selected as the exposure point concentration, both aluminum and cadmium exceed vertebrate screening values. However, when the 95th UCL is selected as the exposure point concentration, cadmium is the only analyte in excess of a vertebrate screening value (Appendix A).

## 7.0 CONCLUSIONS

Through the evaluation of field observations, sampling and analysis results, and the results of the human health and ecological PREs, groundwater downgradient of the WWTP and surface soil downslope of the sludge drying beds were identified as areas of concern. Contaminants detected in surface water and sediment samples collected from the Nashua River are not measurably derived from the subject SAs and have been addressed in a separate evaluation (ADL, 1994).

### 7.1 GROUNDWATER

Arsenic and cadmium were detected in groundwater at concentrations slightly above applicable human health standards and guidelines. However, the average concentrations of these analytes in the selected downgradient wells (21.1  $\mu\text{g/l}$  and 4.2  $\mu\text{g/l}$ , respectively) are below these standards (50  $\mu\text{g/l}$  and 5  $\mu\text{g/l}$ , respectively). Sodium was detected in several downgradient monitoring wells at concentrations above the Massachusetts drinking water guideline (a notification requirement only), but the average concentration in downgradient wells (30,030  $\mu\text{g/l}$ ) is slightly greater than the guideline concentration (28,400  $\mu\text{g/l}$ ).

Only two organic compounds (B2EHP and TCE) were detected in monitoring wells downgradient of the WWTP at concentrations above their respective standards and guidelines. The contaminants likely pose no significant threat to human health and the environment, because the suspected source of TCE has been determined to be an isolated point source release, and the most recent concentration of TCE (measured after the human health PRE was completed) is below the MCL and is declining with time (Figure 7-1). The B2EHP detected in groundwater collected from four of seven selected downgradient wells was determined to be a laboratory contaminant.

The 2,4-dinitrotoluene detected in WWTMW-02 at a concentration below the USEPA Region III tap water concentration during the first round of sampling poses no significant threat to human health or the environment. However, elevated concentrations of nitrate/nitrite detected in downgradient monitoring wells did exceed state and federal drinking water standards. But nitrate/nitrite is

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not considered a hazardous waste by the USEPA, and thus it does not constitute a hazardous waste issue for the WWTP.

### 7.2 SOILS

The human health PRE and the initial ecological PRE identified potential risk from the inorganic analytes detected in surface soils downslope of the sludge drying beds. Manganese, beryllium, and arsenic were identified in the human health PRE, and most of the inorganic analytes were identified in the initial ecological PRE. For manganese, beryllium, and arsenic, the maximum concentrations were determined to be in excess of applicable human health standards and guidelines, but average values for each were not considered significant when compared to either the applicable Region III residential soil concentrations or the calculated Fort Devens background concentrations. In the absence of other organic constituents (from the PAL VOCs and SVOCs), elevated concentrations of TPHC in soils were determined to be unrelated to contaminants released from the sludge drying beds. Further, considering the abundance of leaf litter observed in the floodplain, the TPHC are likely attributable to natural organic debris.

The initial ecological PRE determined that ecological receptors downslope of the sludge drying beds may be at risk from inorganic contamination in floodplain surface soils adjacent to the sludge drying beds. In particular, concentrations of arsenic, barium, copper, lead, mercury, selenium, and vanadium in surface soil exceeded small mammal PCLs developed through the food web model. In addition, silver was detected at high concentrations in the floodplain surface soils. With the exception of copper, PCLs derived from the food web model for organisms other than small mammals (i.e., robin, garter snake, red fox, and red-tailed hawk) are greater than the maximum detected concentrations of these inorganics. Therefore, based on the methodology used in the initial PRE, it is unlikely that inorganic contamination, with the possible exceptions of silver and copper, will have impacts on higher trophic level receptors.

The ecological PRE was revised in June, 1995. Data collected from the five additional sampling points (April 1995) were used to recalculate maximum and average concentration values for each of the inorganic analytes detected. The revised PRE indicates that copper, mercury, silver, and barium (associated with supernatant discharges from the sludge-drying beds) do not exceed their

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respective screening values. Based on these findings, it is unlikely that the analytes derived from supernatant discharges pose a significant potential threat to ecological receptors.

### **7.3 RECOMMENDATIONS**

Given that no unacceptable threats to human health or the environment due to hazardous waste contamination were identified in groundwater downgradient of the WWTP, no further action under CERCLA is appropriate for groundwater at SAs 19, 20 and 21. It is appropriate, however, that the nitrate/nitrite contamination observed in downgradient groundwater be addressed outside this Superfund hazardous waste site process as part of a compliance upgrading of the facility.

In surface soil at SA 21, concentrations of inorganic analytes derived from the former supernatant discharge pipe are below their respective screening values. At the 95th UCL, only cadmium exceeds its screening value. Cadmium is not associated with supernatant discharges. Its concentrations are consistent with levels detected in Nashua River samples collected nearby, and the areal distribution of cadmium at SA 21 indicates an association with river deposition along the floodplain.

The removal of cadmium-contaminated soil could potentially involve a large area of forested floodplain along the Nashua River and would be very disruptive of ecological habitat. Further, surface soil would be recontaminated by future periodic flooding of the Nashua River. The impermanence and detrimental effects of a removal action outweigh the existing risks to receptors. Therefore, no further action is recommended for SAs 19, 20, and 21.

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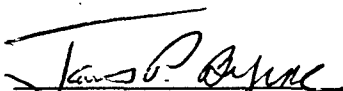
## 8.0 DECISION

On the basis of findings at SAs 19, 20 and 21, there is no evidence or reason to conclude that the past and present operation of the WWTP has caused significant hazardous waste contamination, or poses a threat to human health or the environment. The decision has been made to remove SAs 19, 20 and 21 from further consideration in the IRP process, and that any further action should be addressed under applicable regulations and standards.

  
JAMES C. CHAMBERS  
BRAC Environmental Coordinator

2 Nov 95  
Date

## U.S. ENVIRONMENTAL PROTECTION AGENCY


  
JAMES P. BYRNE  
Fort Devens Remedial Project Manager

11/2/95  
Date

☒ Concur

☐ Non-concur (Please provide reasons for non-concurrence in writing)

## MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION

  
D. LYNNE WELSH  
Section Chief, Federal Facilities - CERO

11/2/95  
Date

☒ Concur

☐ Non-concur (Please provide reasons for non-concurrence in writing)

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## **GLOSSARY OF ACRONYMS AND ABBREVIATIONS**

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ABB-ES	ABB Environmental Services, Inc.
ADL	Arthur D. Little, Inc.
AEHA	U.S. Army Environmental Hygiene Agency
AREE	Area Requiring Environmental Evaluation
B2EHP	bis(2-ethylhexyl)phthalate
BRAC	Defense Base Realignment and Closure Act of 1990
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CPC	Chemicals of Potential Concern
DoD	U.S. Department of Defense
ESE	Environmental Science and Engineering, Inc.
ft	foot or feet
gpm	gallons per minute
HI	Hazard Index
IRP	Installation Restoration Program
MADEP	Massachusetts Department of Environmental Protection
MEP	Master Environmental Plan
MGD	million gallons per day
MNHP	Massachusetts Natural Heritage Program
MSL	mean sea level
PA	Preliminary Assessment
PAL	Project Analyte List
PCL	Protective Contaminant Level
PRE	Preliminary Risk Evaluation
SA	Study Area
SI	site investigation
SOW	Statement of Work
SSI	Supplemental Site Investigation

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**ABB Environmental Services, Inc.**

## GLOSSARY OF ACRONYMS AND ABBREVIATIONS

---

SVOC	semivolatile organic compound
TCA	1,1,1-trichloroethane
TCE	trichloroethylene
TCFM	trichlorofluoromethane
TOC	total organic carbon
TPHC	total petroleum hydrocarbon compounds
TSS	total suspended solids
$\mu\text{g/g}$	micrograms per gram
$\mu\text{g/kg}$	micrograms per kilogram
$\mu\text{g/l}$	micrograms per liter
USAEC	U.S. Army Environmental Center
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound
WWTP	wastewater treatment plant

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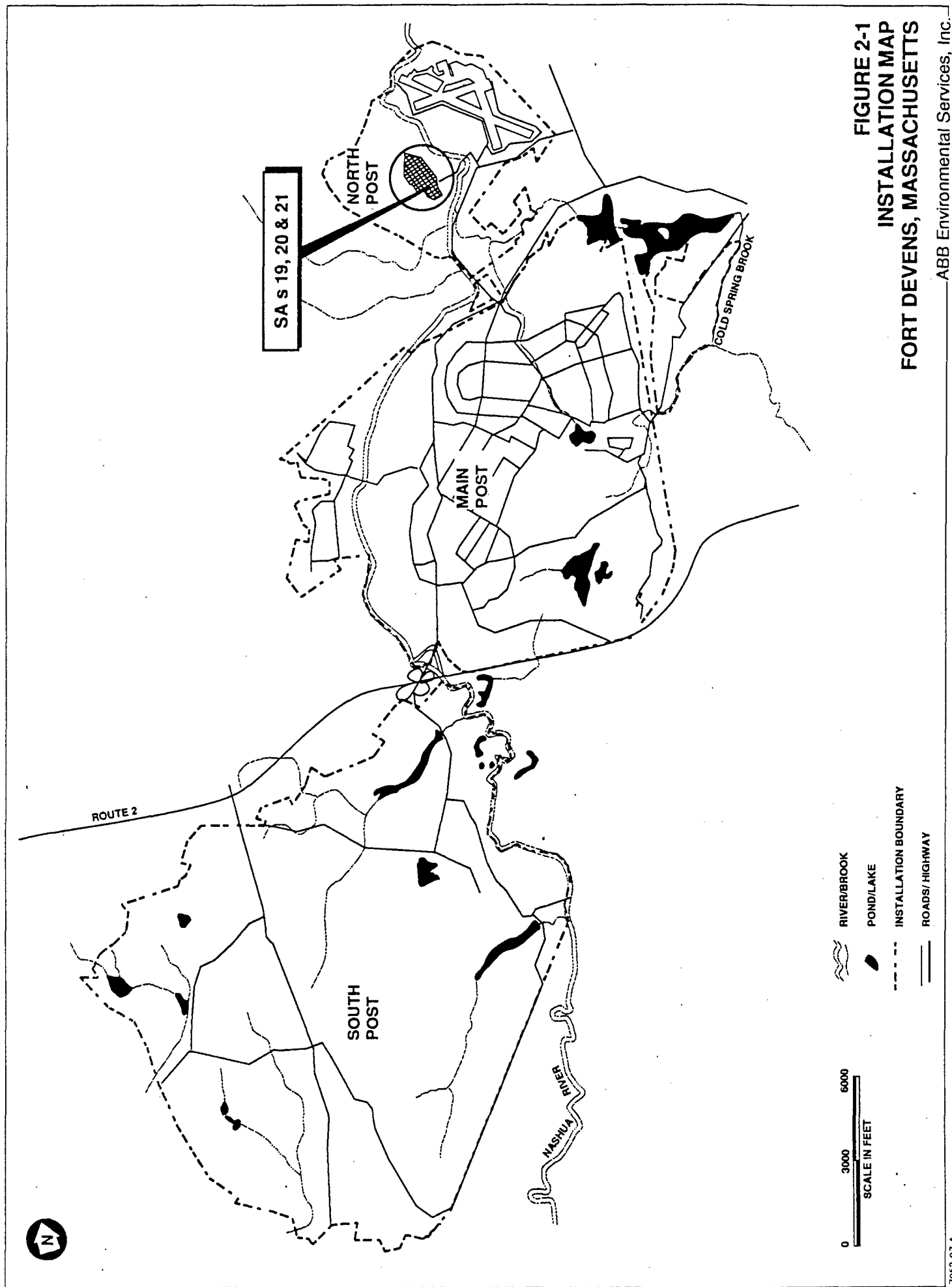
ABB Environmental Services, Inc.

## REFERENCES

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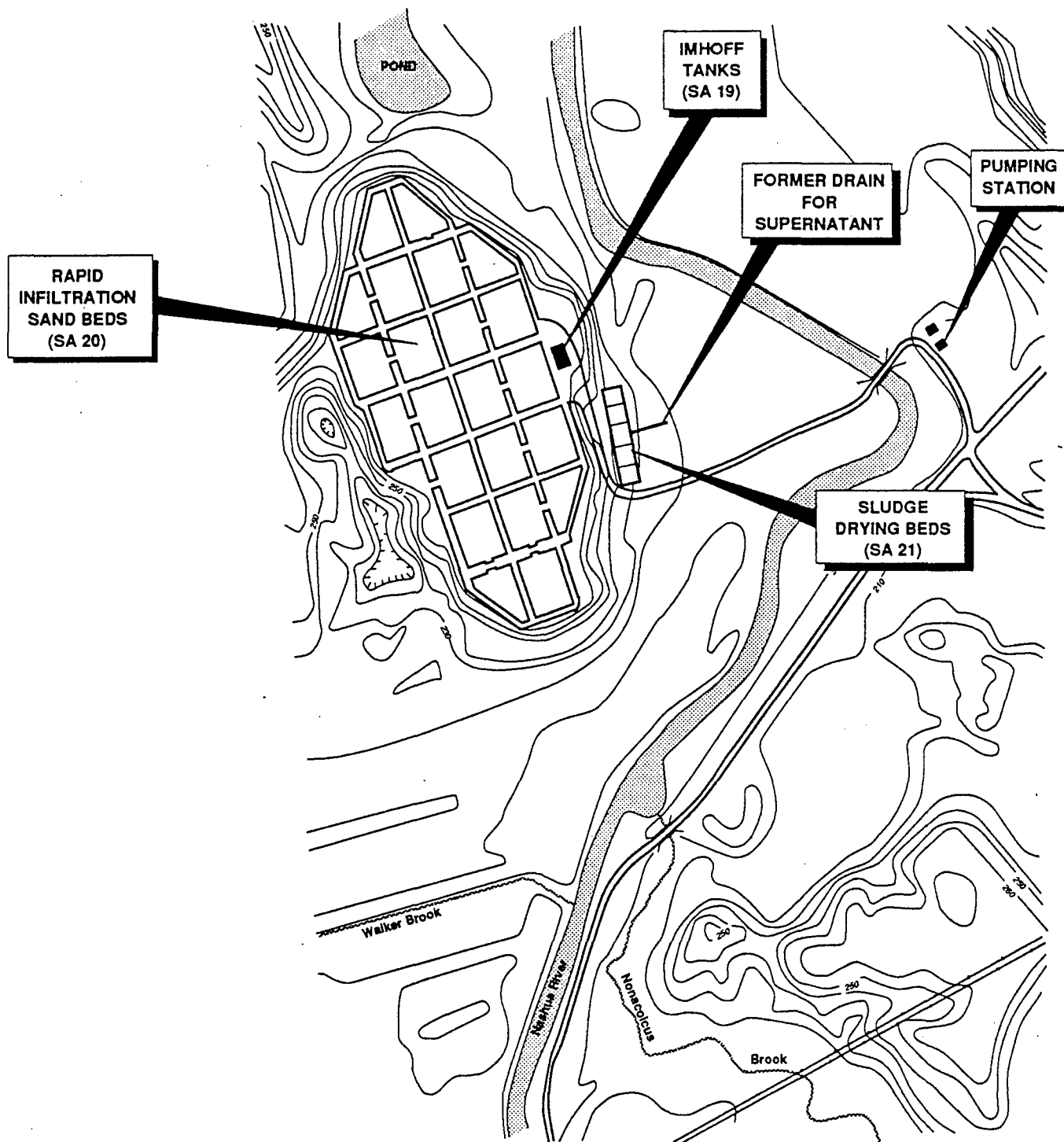
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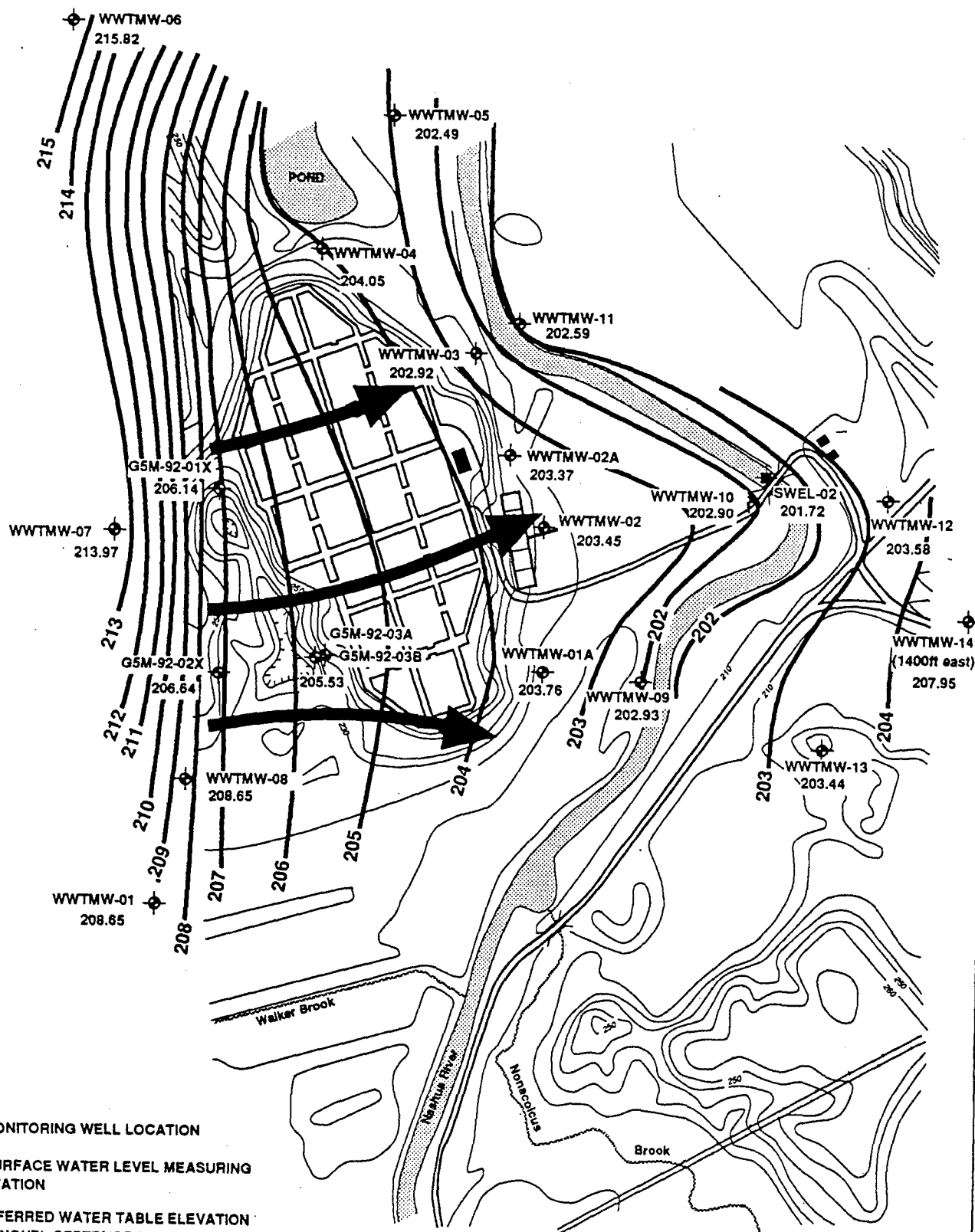
**FIGURE 2-1**  
**INSTALLATION MAP**  
**FORT DEVENS, MASSACHUSETTS**

ABB Environmental Services, Inc.



**FIGURE 2-2**  
**LOCATION OF SAs 19, 20 & 21**  
**FORT DEVENS, MA**

ABB Environmental Services, Inc.



#### LEGEND



MONITORING WELL LOCATION



SURFACE WATER LEVEL MEASURING STATION

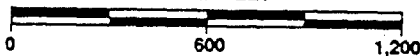
208 —

INFERRED WATER TABLE ELEVATION  
(ft NGVD), SEPTEMBER 15, 1992



INFERRED GROUNDWATER FLOW  
DIRECTION, SEPTEMBER 15, 1992

SCALE IN FEET

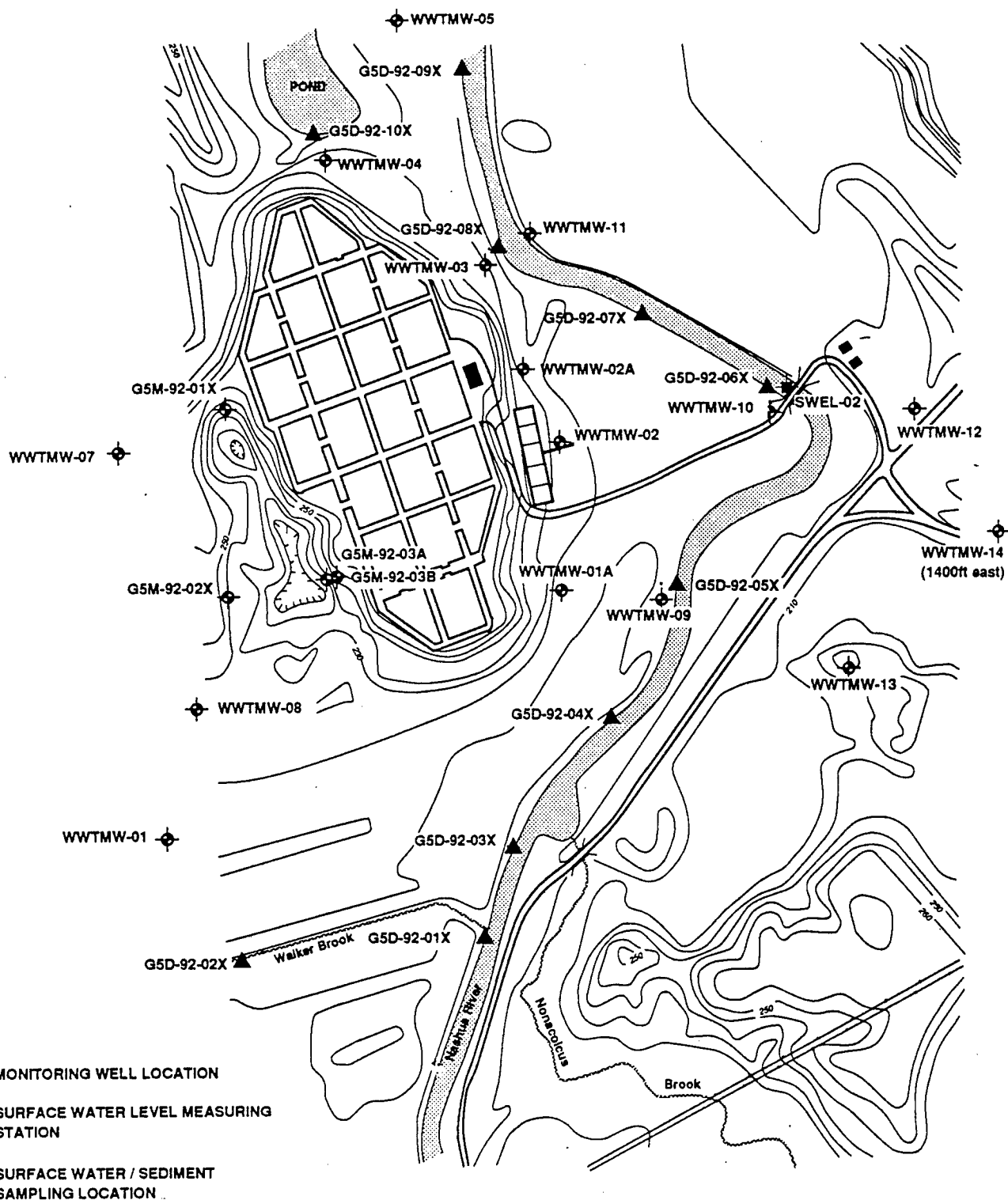


**FIGURE 3-1  
GROUNDWATER LEVELS AND  
INFERRED FLOW DIRECTIONS  
GROUP 5 STUDY AREAS  
FORT DEVENS, MA**

ABB Environmental Services, Inc.



WWTMW-06



**LEGEND**



MONITORING WELL LOCATION

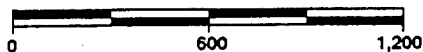


SURFACE WATER LEVEL MEASURING  
STATION



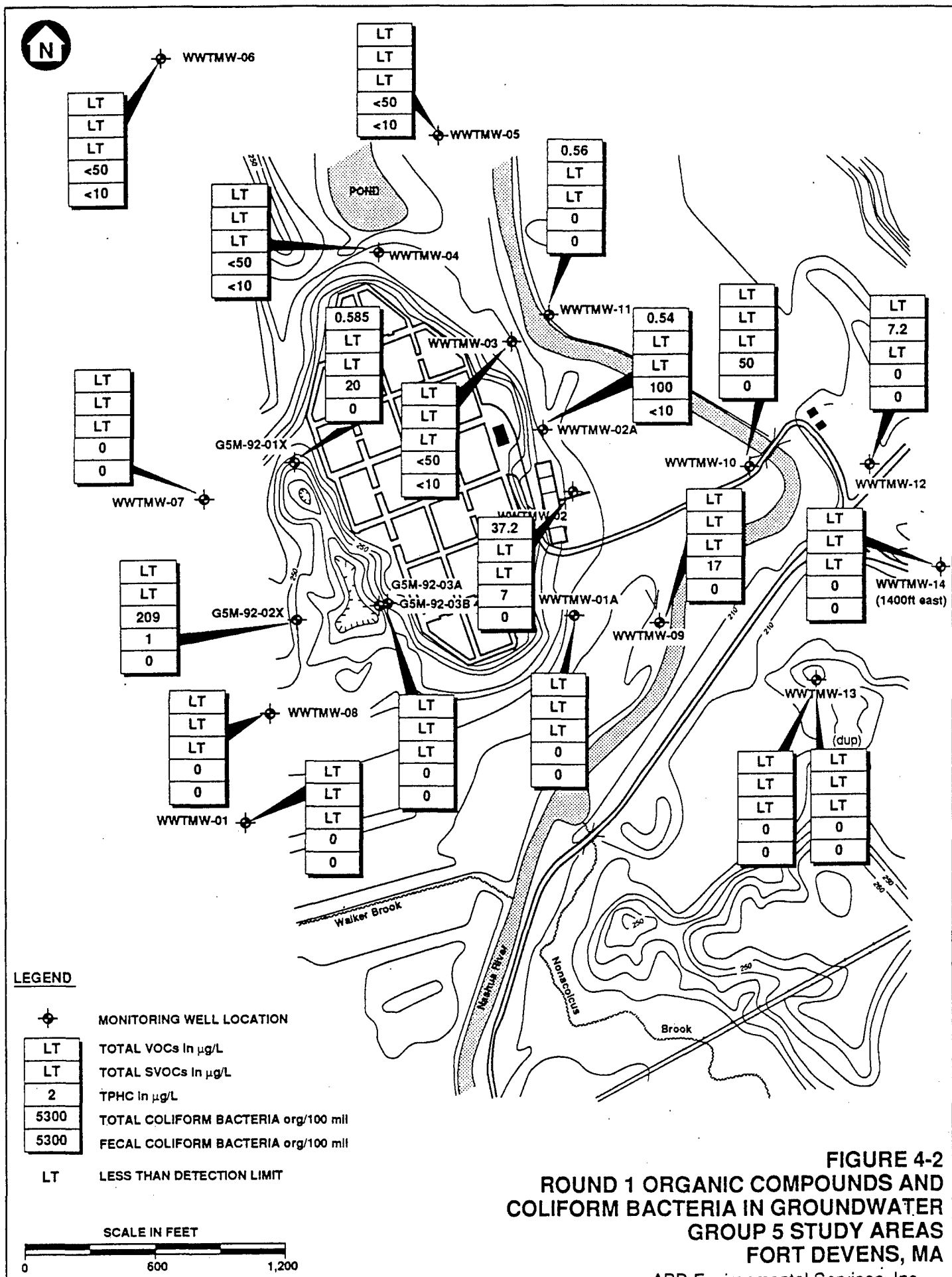
SURFACE WATER / SEDIMENT  
SAMPLING LOCATION

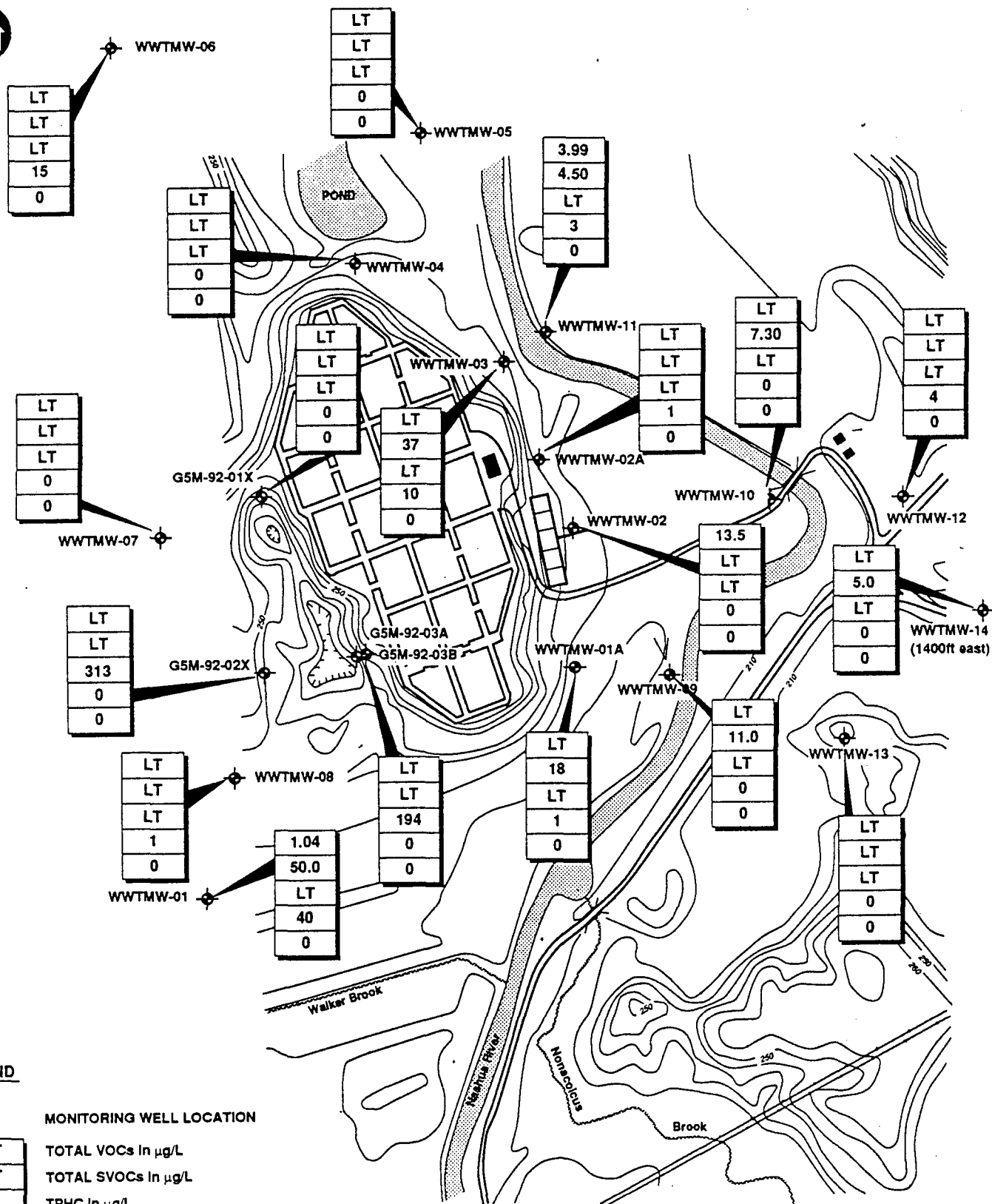
SCALE IN FEET



**FIGURE 4-1  
EXPLORATION LOCATIONS  
GROUP 5 STUDY AREAS  
FORT DEVENS, MA**

ABB Environmental Services, Inc.





#### LEGEND



MONITORING WELL LOCATION

LT
LT
2
5300
5300

TOTAL VOCs In  $\mu\text{g/L}$

TOTAL SVOCs In  $\mu\text{g/L}$

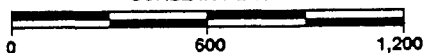
TPHC In  $\mu\text{g/L}$

TOTAL COLIFORM BACTERIA org/100 ml

FECAL COLIFORM BACTERIA org/100 ml

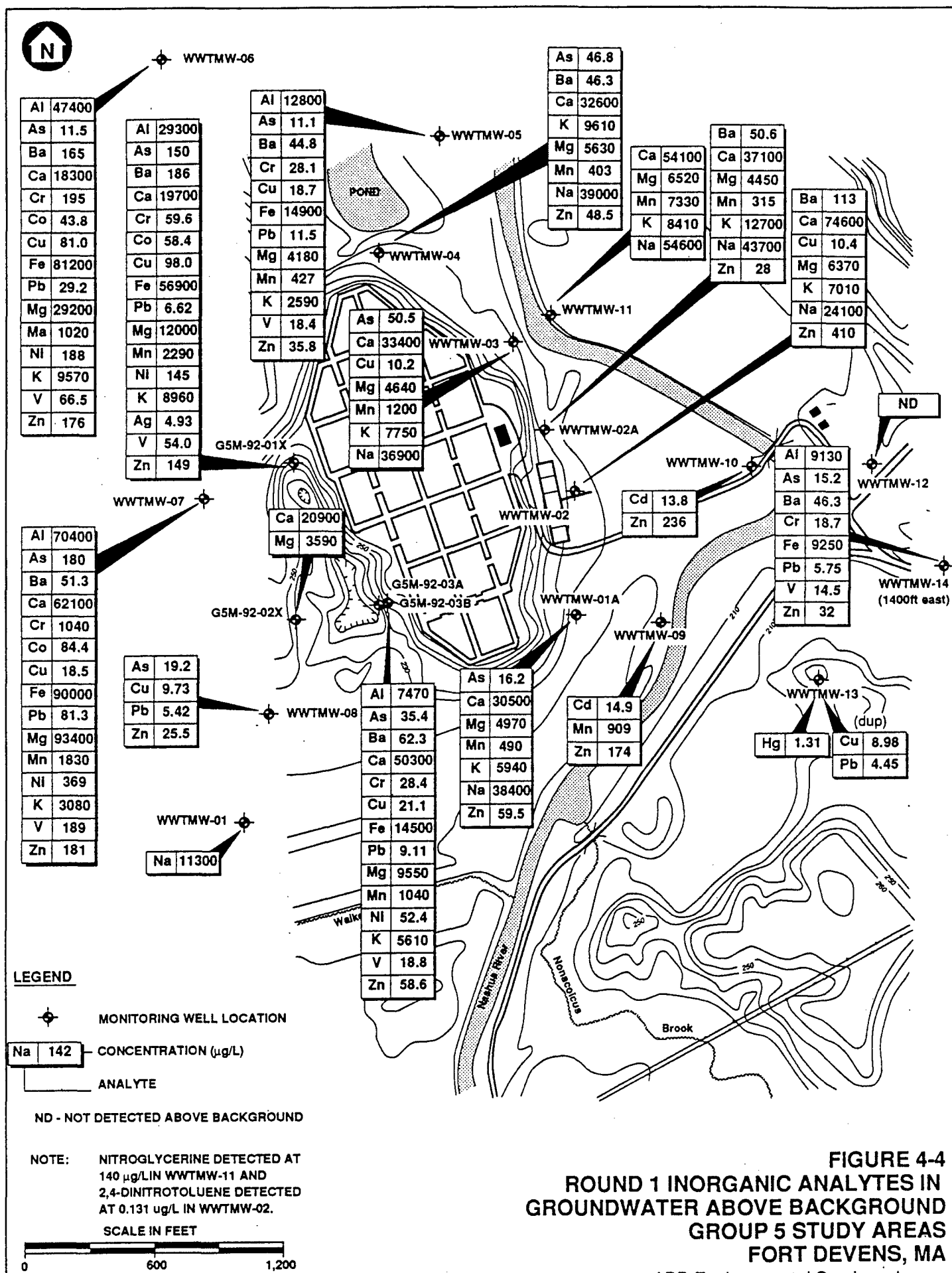
LT LESS THAN DETECTION LIMIT

SCALE IN FEET



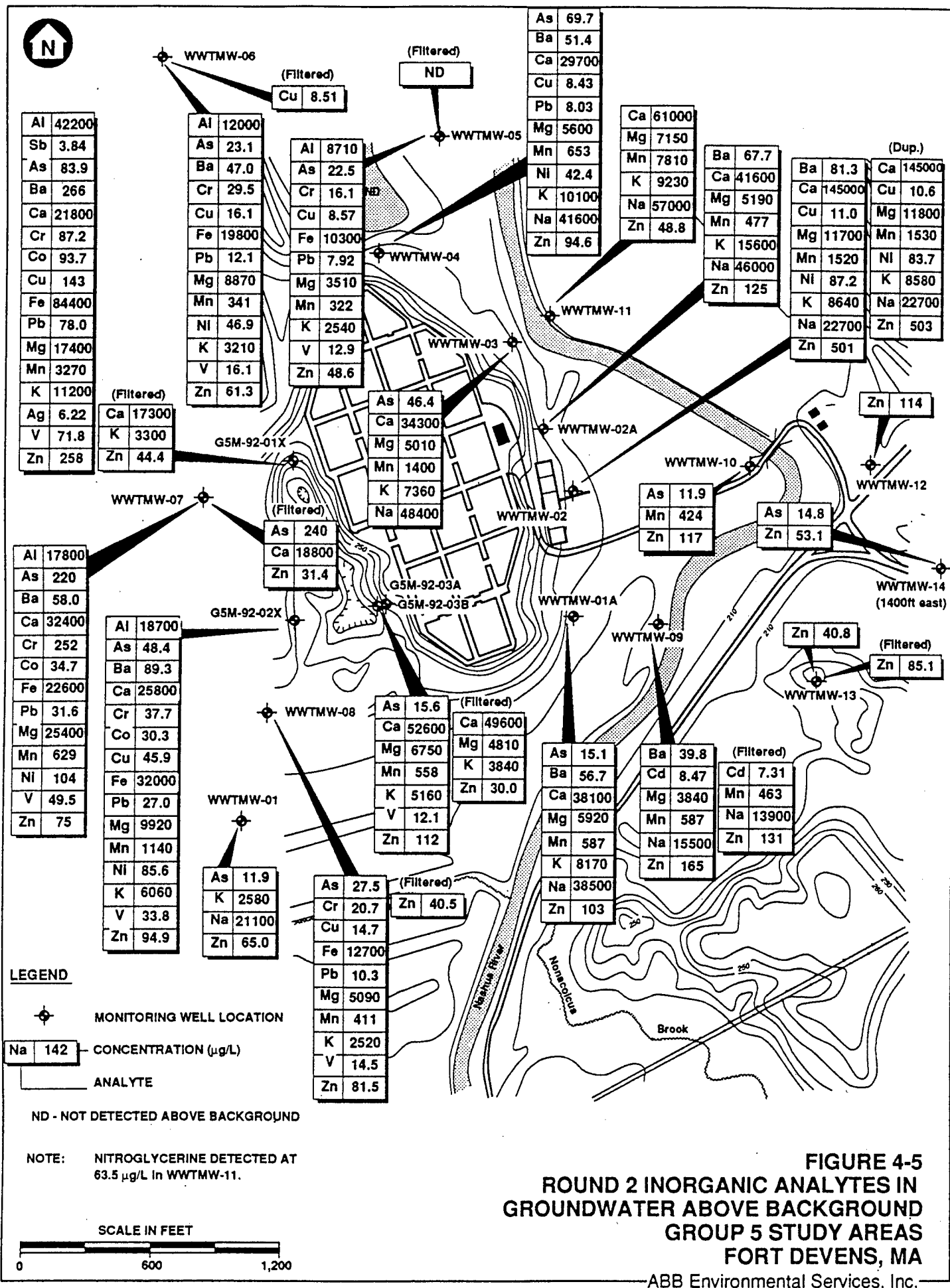
**FIGURE 4-3**  
**ROUND 2/3 ORGANIC COMPOUNDS AND**  
**COLIFORM BACTERIA IN GROUNDWATER**  
**GROUP 5 STUDY AREAS**  
**FORT DEVENS, MA**

ABB Environmental Services, Inc.

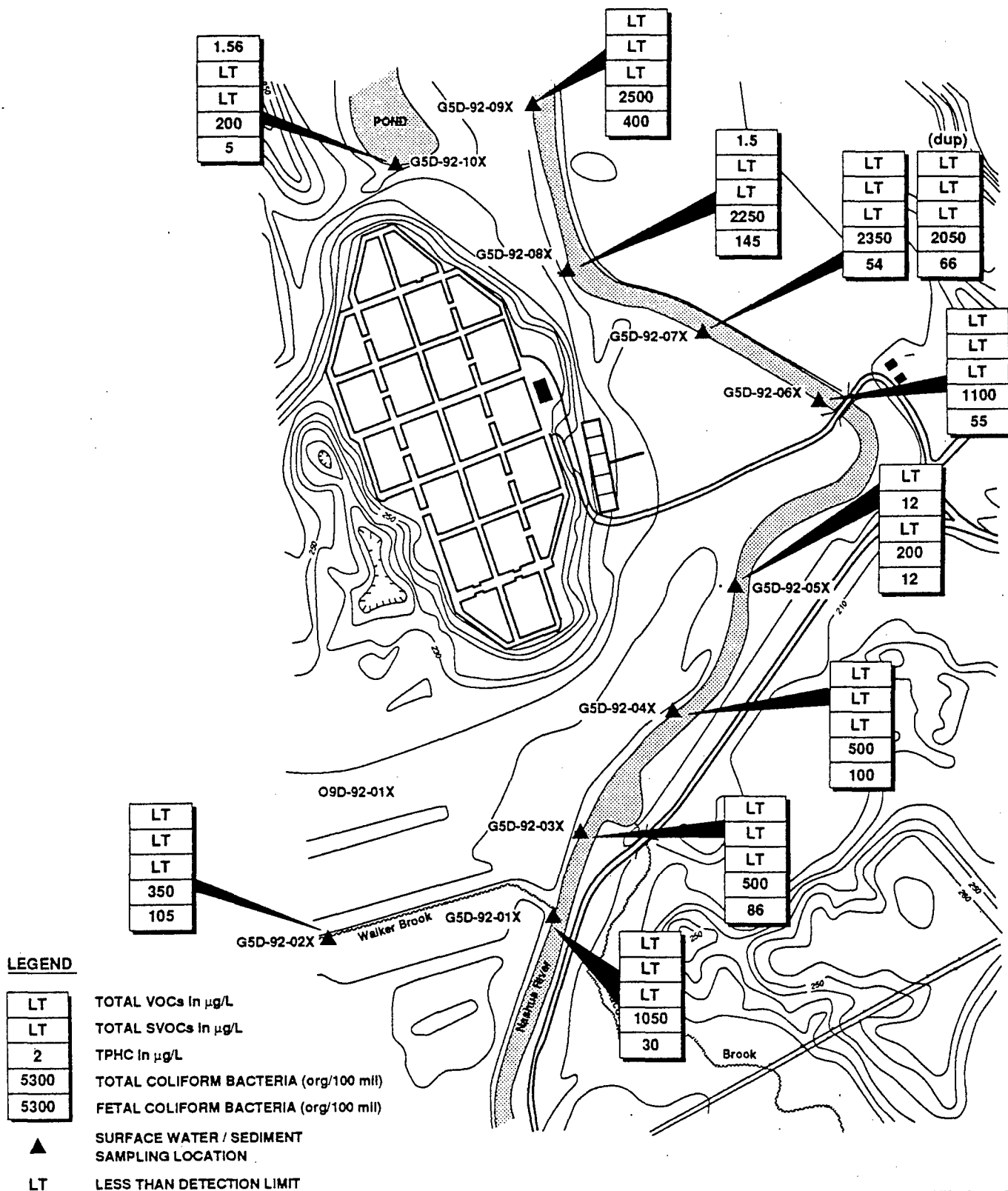


**FIGURE 4-4**  
**ROUND 1 INORGANIC ANALYTES IN**  
**GROUNDWATER ABOVE BACKGROUND**  
**GROUP 5 STUDY AREAS**  
**FORT DEVENS, MA**

ABB Environmental Services, Inc.









Ba	29.7
Ca	8220
Fe	574
Pb	5.75
Mg	1190
Mn	169
K	714
Na	10800

As	3.62
Ba	5.59
Ca	10100
Fe	175
Mg	2800
Mn	12.8
Na	19000

Al	180
As	2.77
Ba	17.7
Ca	13800
Fe	786
Pb	2.71
Mg	1910
Mn	153
K	2420
Na	26400

As	2.98
Ba	20
Ca	14300
Fe	691
Pb	3.9
Mg	1900
Mn	117
K	2860
Na	32200

Al	LT
As	3.09
Ba	17.2
Ca	12500
Fe	786
Pb	5.21
Mg	1790
Mn	126
K	2570
Na	23700

(dup)	
Al	144
As	LT
Ba	17.9
Ca	12900
Fe	824
Pb	5.75
Mg	1860
Mn	131
K	2710
Na	24300

As	2.88
Ba	17.2
Ca	12500
Fe	779
Mg	1810
Mn	125
K	2120
Na	23400

As	2.98
Ba	18.1
Ca	11700
Fe	773
Pb	6.51
Mg	1730
Mn	111
K	2020
Na	21900

Ba	18.8
Ca	11700
Fe	789
Pb	4.01
Mg	1750
Mn	109
K	1950
Na	21700

Al	142
As	3.09
Ba	17.4
Ca	11400
Fe	811
Pb	4.23
Mg	1730
Mn	103
K	1580
Na	20900

As	2.88
Ba	18.1
Ca	11300
Fe	851
Pb	5.1
Mg	1650
Mn	106
K	1600
Na	20600

#### LEGEND

Na	142
----	-----

CONCENTRATION ( $\mu\text{g/L}$ )

ANALYTE

LT

LESS THAN DETECTION LIMIT



SURFACE WATER / SEDIMENT SAMPLING LOCATION

SCALE IN FEET

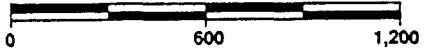
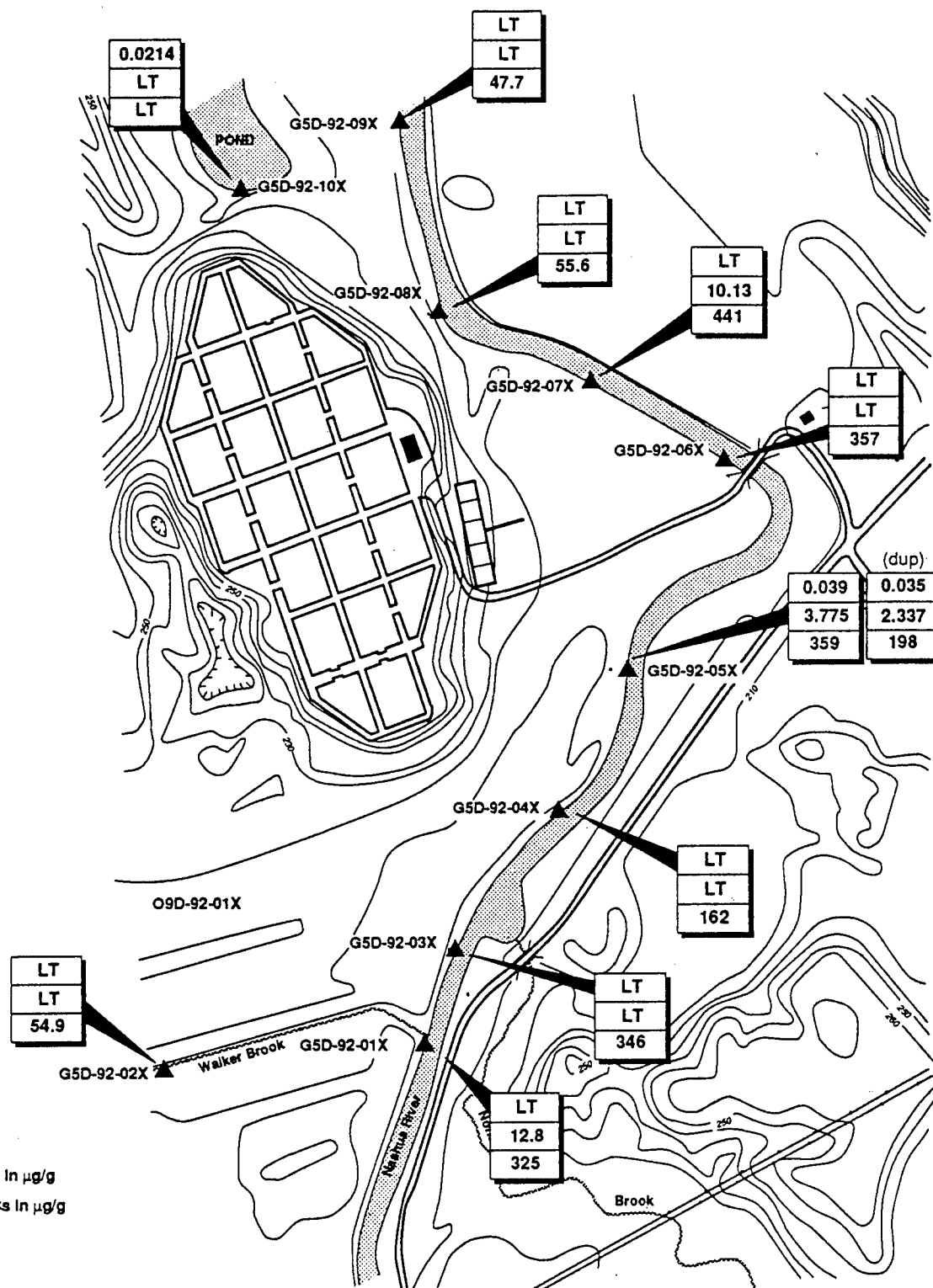


FIGURE 4-7  
INORGANIC ANALYTES DETECTED  
IN SURFACE WATER  
GROUP 5 STUDY AREAS  
FORT DEVENS, MA

ABB Environmental Services, Inc.



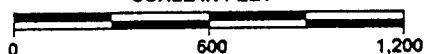
LT
209
LT

TOTAL VOCs In µg/g  
TOTAL SVOCs In µg/g  
TPHC In µg/g

▲ SURFACE WATER / SEDIMENT  
SAMPLING LOCATION

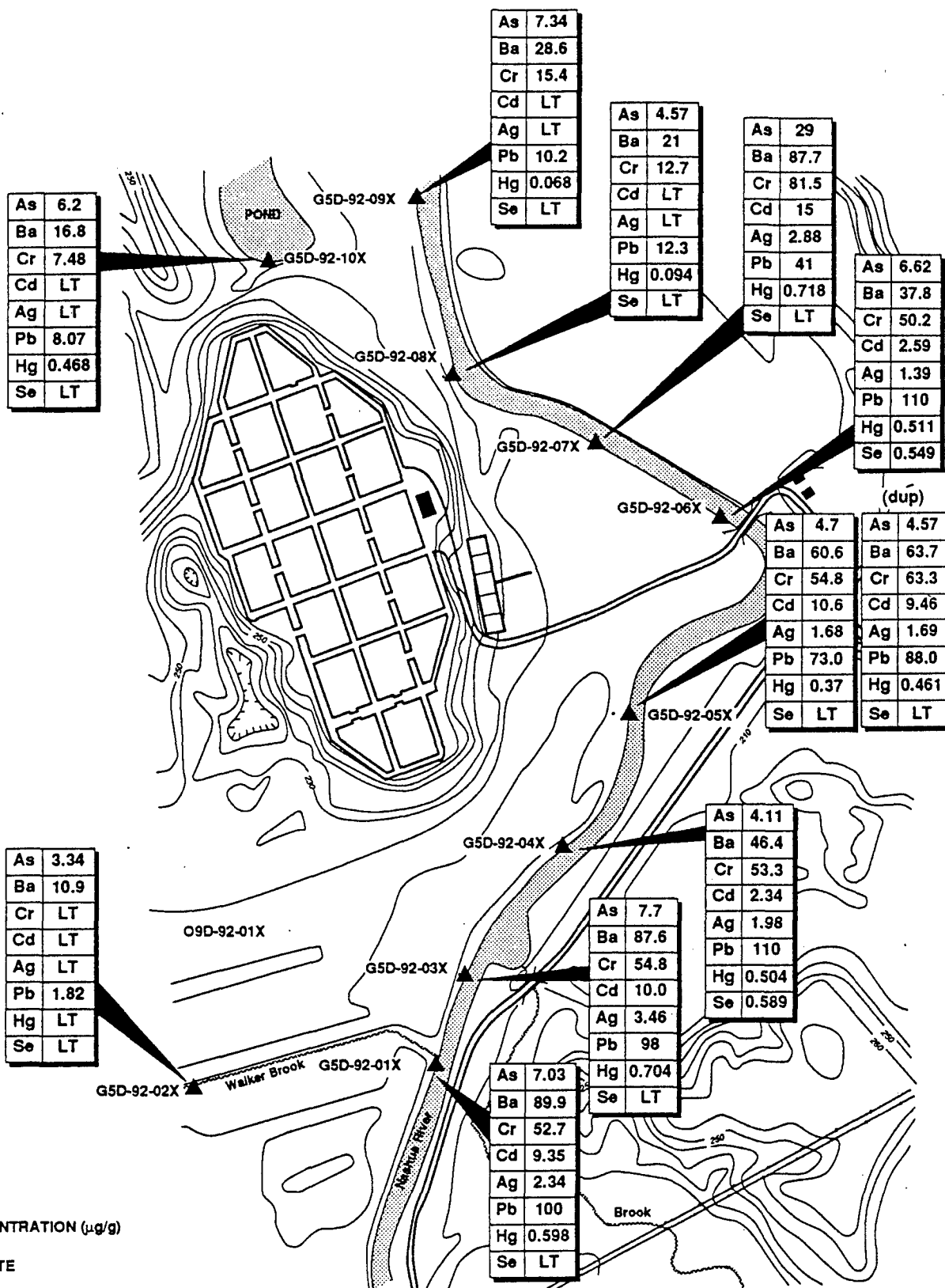
LT LESS THAN DETECTION LIMIT

**SCALE IN FEET**



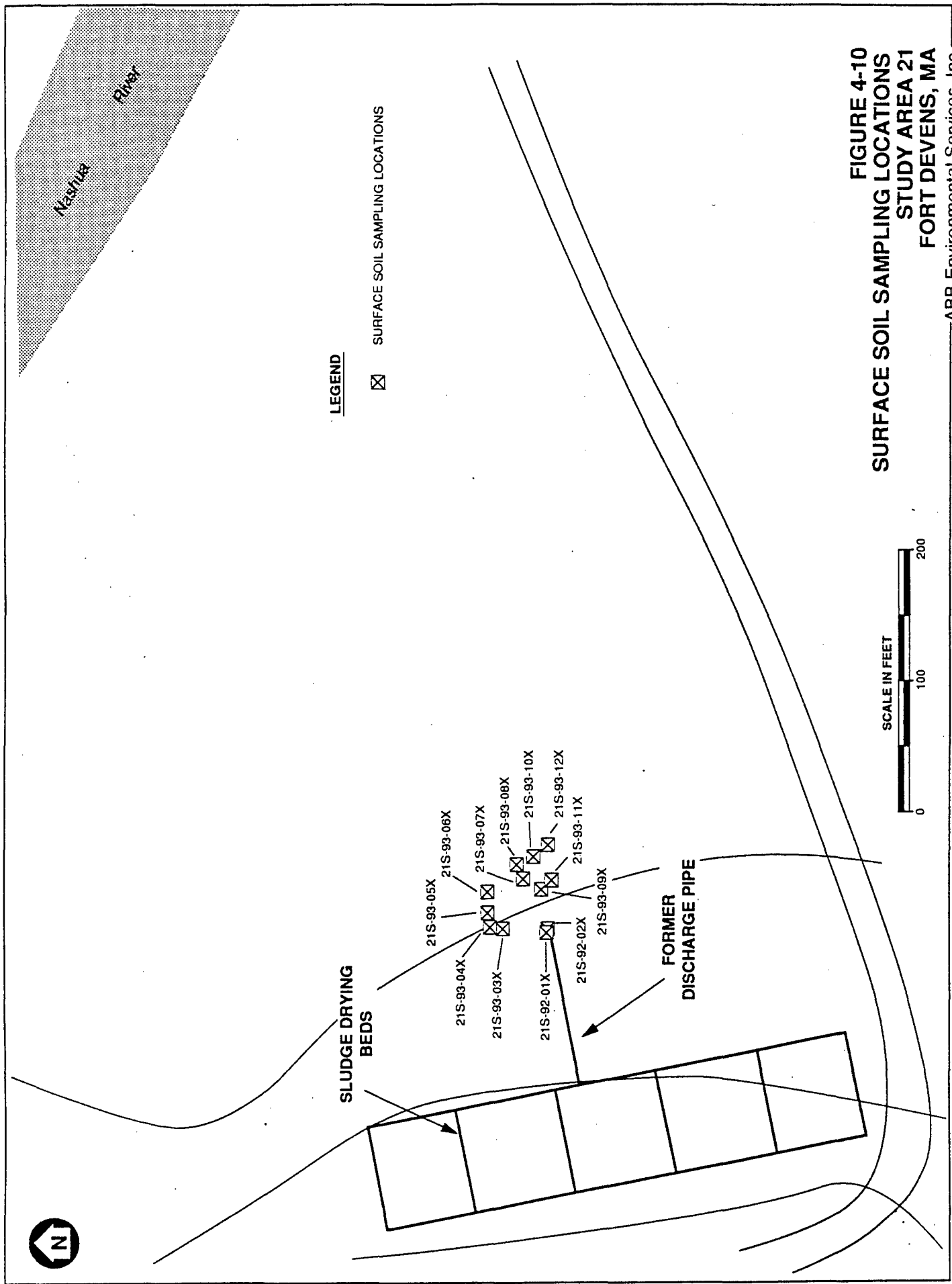
**FIGURE 4-8  
ORGANIC COMPOUNDS IN SEDIMENT  
GROUP 5 STUDY AREAS  
FORT DEVENS, MA**

-ABB Environmental Services, Inc.

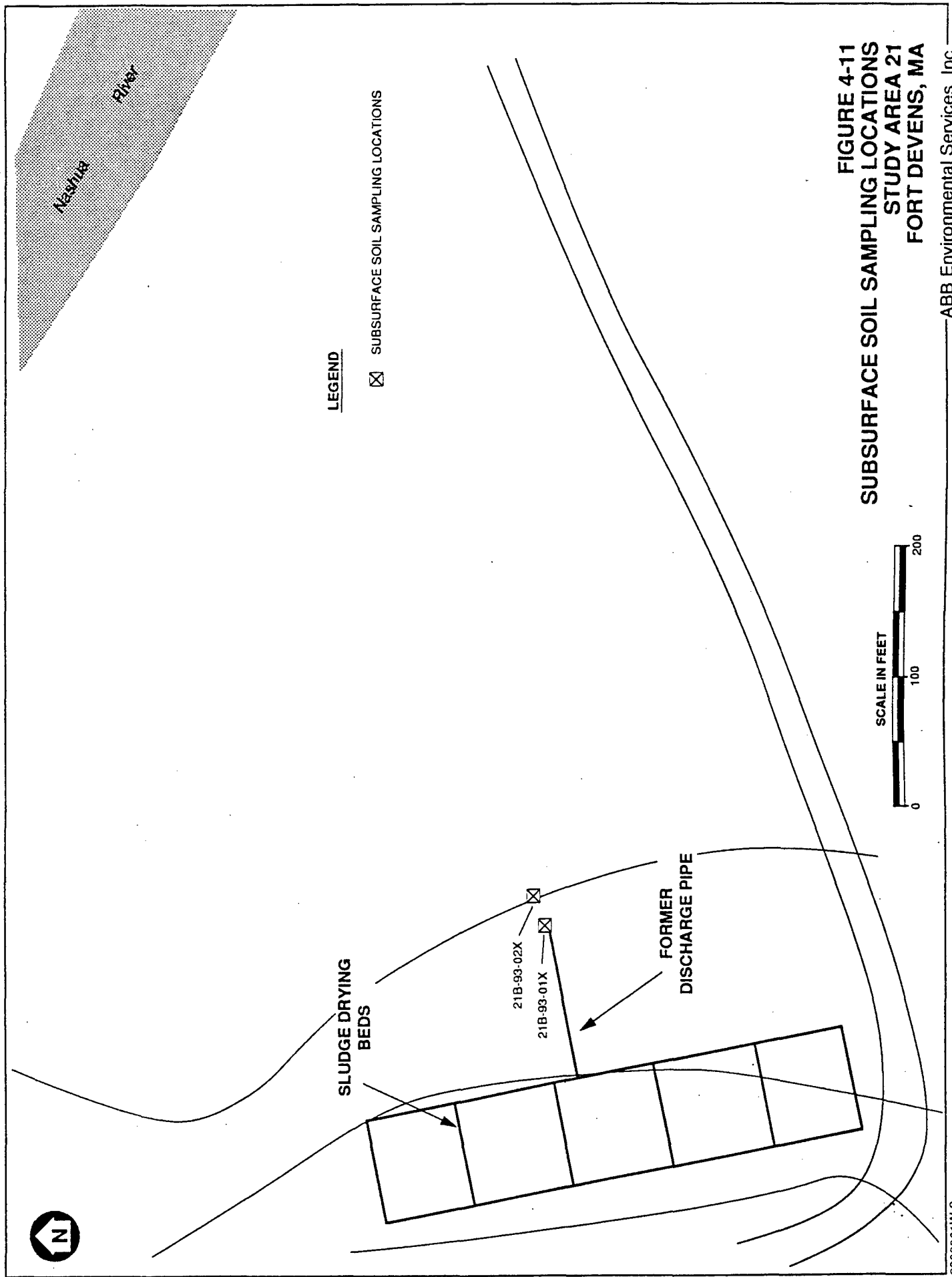


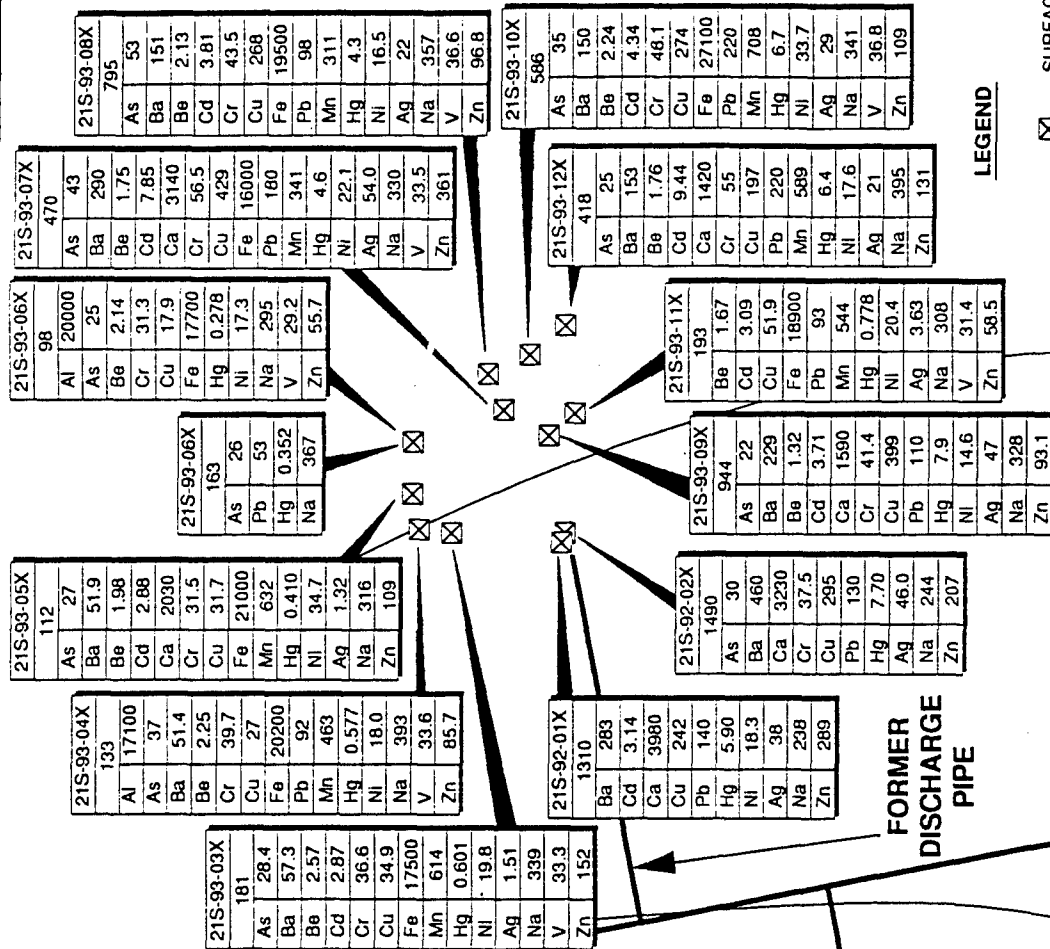
**FIGURE 4-9**  
**SELECTED INORGANIC ANALYTES**  
**IN SEDIMENT**  
**GROUP 5 STUDY AREAS**  
**FORT DEVENS, MA**

ABB Environmental Services, Inc.



**FIGURE 4-10**  
**SURFACE SOIL SAMPLING LOCATIONS**  
**STUDY AREA 21**  
**FORT DEVENS, MA**  
 ABB Environmental Services, Inc.





SLUDGE DRYING  
BEDS

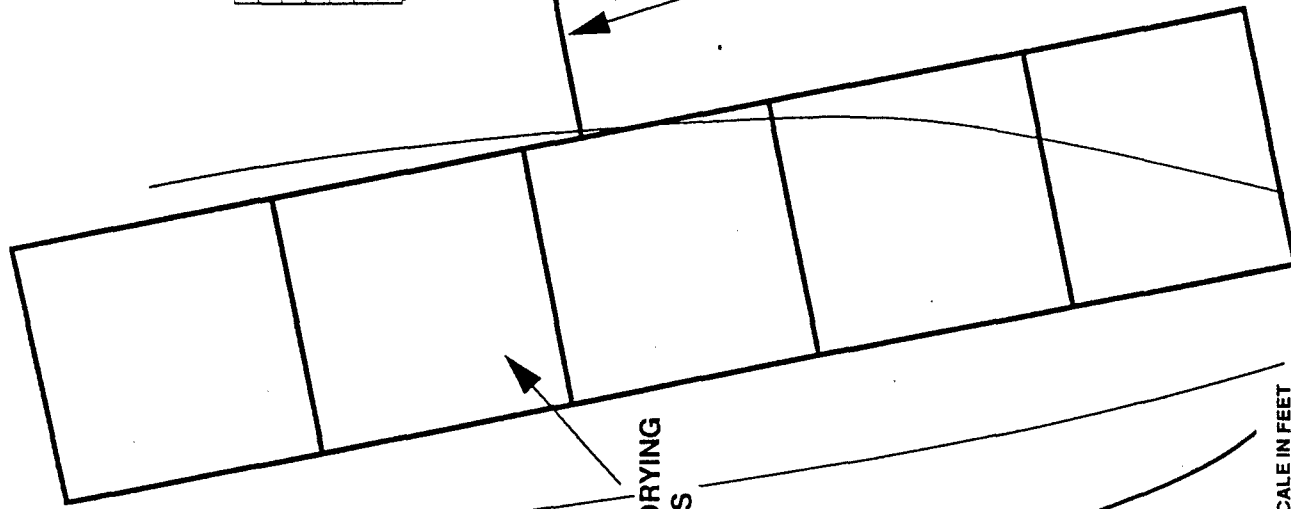
FORMER  
DISCHARGE  
PIPE

SCALE IN FEET



FIGURE 4-12  
ANALYTES IN SURFACE SOIL, (0-2 FT)  
STUDY AREA 21  
FORT DEVENS, MA

ABB Environmental Services, Inc.



21B-93-02X	
0	
Be	1.22
Cu	9.3
Na	204

21B-93-01X		
	0	
	Be	1.24
	Cu	10.9
	Ni	16.1
	Na	230
	Zn	75.4

# LEGEND

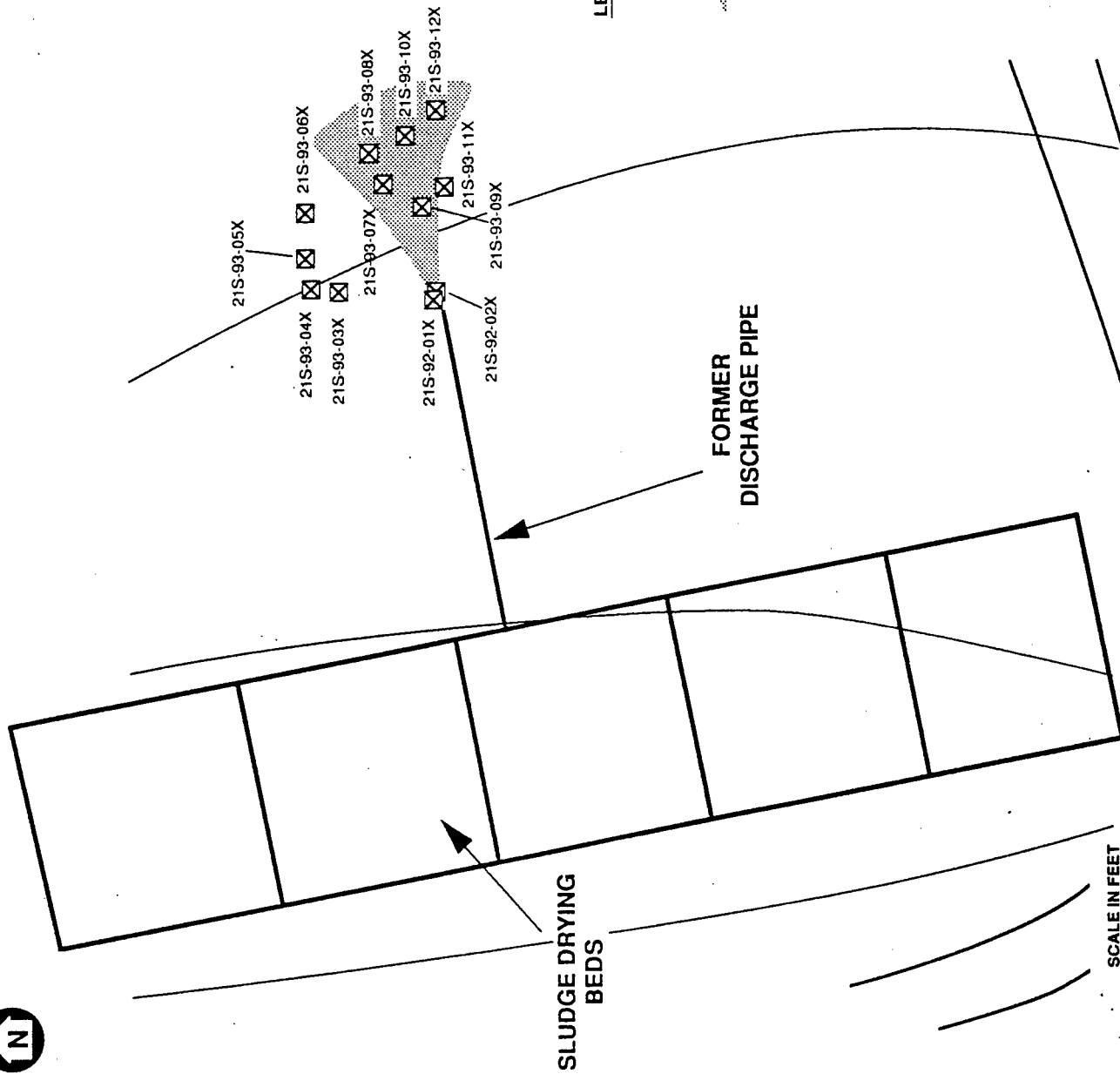
☒ SUBSURFACE SOIL SAMPLING LOCATIONS

21S-93-06X	Sample Identification
163	Total Petroleum Hydrocarbons in (µg/g)
As	Concentration in (µg/g)
26.4	Inorganic Analytes above background in (µg/g)

FIGURE 4-13  
ANALYTES IN SUBSURFACE SOIL, (2-4 FT)  
STUDY AREA 21  
FORT DEVENS, MA







**LEGEND**



SURFACE SOIL SAMPLING LOCATIONS



APPROXIMATE LIMITS OF SUPERNATANT  
DISCHARGE CONTAMINANTS

**FIGURE 4-14**  
**CONTAMINANT DISTRIBUTION IN**  
**SURFACE SOIL**  
**STUDY AREA 21**  
**FORT DEVENS, MA**

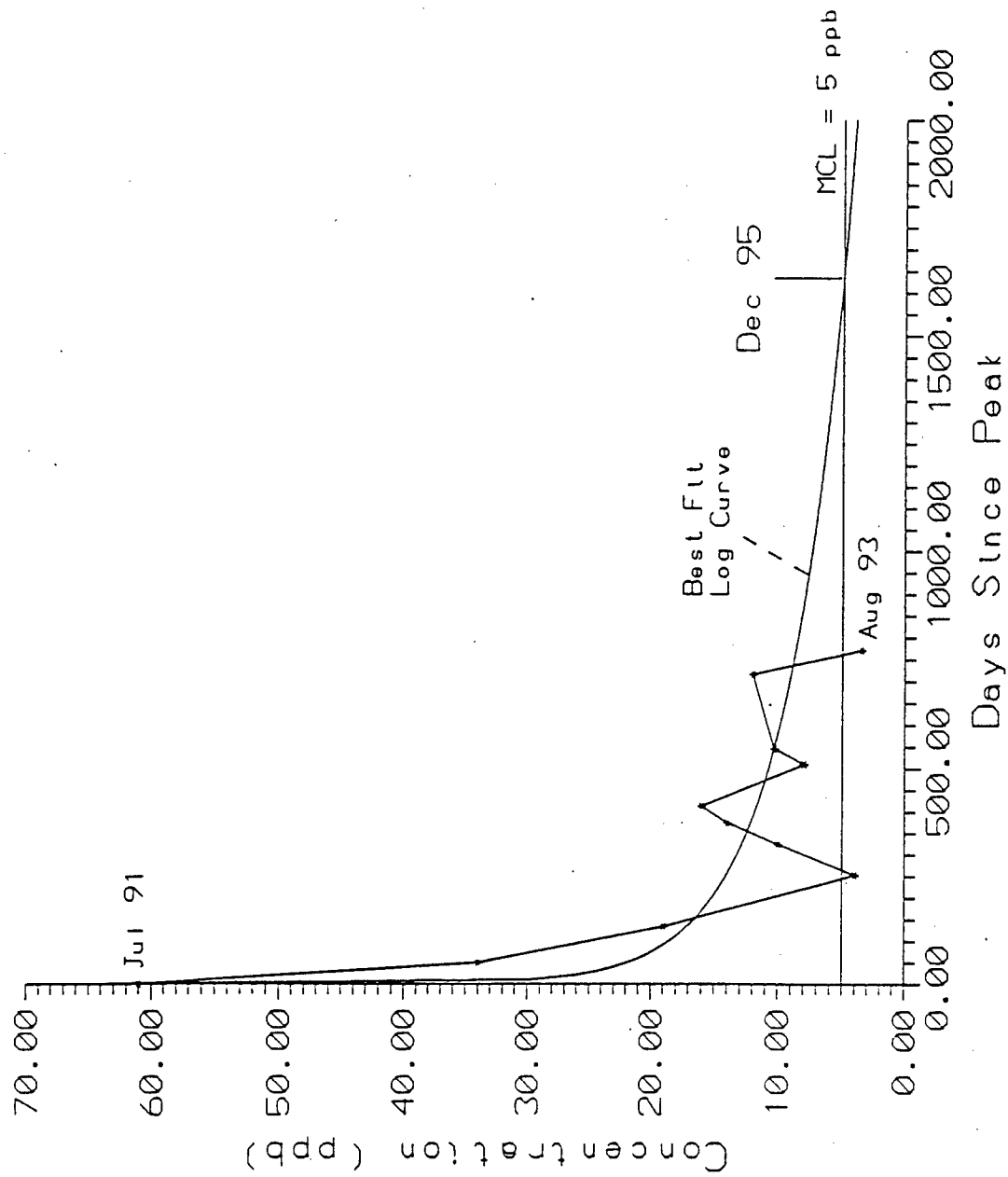


FIGURE 7-1  
TCE IN GROUNDWATER - WWTMW-02  
STUDY AREA 21  
FORT DEVENS, MA

TABLE 4-1  
ORGANIC COMPOUNDS IN GROUNDWATER - ROUND 1 (July 1992)  
GROUP 5 GROUNDWATER MONITORING WELLS

FORT DEVENS

ANALYTE	G5M-92-01X	G5M-92-02X	G5M-92-03B	WWTMW-01	WWTMW-01A	WWTMW-02	WWTMW-02A	WWTMW-03	WWTMW-04	WWTMW-05
<b>ORGANICS (ug/L)</b>										
ACETONE	<13.0	<13.0	<13.0	<13.0	<13.0	18.0	<13.0	<13.0	<13.0	<13.0
BIS(2-ETHYLHEXYL)THIPHALATE	<4.80	<4.80	<4.80	<4.80	<4.80	<4.80	<4.80	<4.80	<4.80	<4.80
CARBON TETRACHLORIDE	<0.580	<0.580	<0.580	<0.580	<0.580	1.40	<0.580	<0.580	<0.580	<0.580
CHLOROFORM	0.585	<0.500	<0.500	<0.500	<0.500	1.60	<0.500	<0.500	<0.500	<0.500
TOLUENE	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	0.540	<0.500	<0.500	<0.500
1,1,1-TRICHLOROETHANE	<0.500	<0.500	<0.500	<0.500	<0.500	2.20	<0.500	<0.500	<0.500	<0.500
TRICHLOROETHENE	<0.500	<0.500	<0.500	<0.500	<0.500	14.0	<0.500	<0.500	<0.500	<0.500
TOTAL PETROLEUM HYDROCARBONS	<200	209	<200	<200	<200	<200	<200	<200	<200	<200
<b>COLIFORM BACTERIA</b>										
TOTAL (org/100ml)	20	1	0	0	0	7	100	<50	<50	<50
FECAL (org/100ml)	0	0	0	0	0	0	<10	<10	<10	<10

ANALYTE	WWTMW-06	WWTMW-07	WWTMW-08	WWTMW-09	WWTMW-10	WWTMW-11	WWTMW-12	WWTMW-13	WWTMW-13D	WWTMW-14
<b>ORGANICS (ug/L)</b>										
ACETONE	<13.0	<13.0	<13.0	<13.0	<13.0	<13.0	<13.0	<13.0	<13.0	<13.0
BIS(2-ETHYLHEXYL)THIPHALATE	<4.80	<4.80	<4.80	<4.80	<4.80	<4.80	7.20	<4.80	<4.80	<4.80
CARBON TETRACHLORIDE	<0.580	<0.580	<0.580	<0.580	<0.580	<0.580	<0.580	<0.580	<0.580	<0.580
CHLOROFORM	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
TOLUENE	<0.500	<0.500	<0.500	<0.500	<0.500	0.560	<0.500	<0.500	<0.500	<0.500
1,1,1-TRICHLOROETHANE	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500
TRICHLOROETHENE	<0.500	<0.500	<0.500	<0.500	<0.500	<1.200	<1.200	<0.500	<0.500	<0.500
TOTAL PETROLEUM HYDROCARBONS	<200	<200	<200	<200	<200	<200	<200	<200	<200	<200
<b>COLIFORM BACTERIA</b>										
TOTAL (org/100ml)	<50	0	0	17	50	0	0	0	0	0
FECAL (org/100ml)	<10	0	0	0	0	0	0	0	0	0

NOTES: TABLE LIST DETECTED ANALYTES ONLY - SEE PROJECT ANALYTE LIST FOR SUMMARY

TABLE 4-2  
ORGANIC COMPOUNDS IN GROUNDWATER - ROUNDS 2 & 3 (Oct 1992/Jan 1993)  
GROUP 5 GROUNDWATER MONITORING WELLS

FORT DEVENS

ANALYTES	GSM-92-01X	GSM-92-01X filter'd	GSM-92-02X	GSM-92-03B	GSM-92-03B filter'd	WWTMW-01	WWTMW-01A	WWTMW-02	WWTMW-02 dup	WWTMW-02A	WWTMW-03	WWTMW-04	WWTMW-05	WWTMW-05 filter'd
<b>ORGANICS (ug/L)</b>														
BIS(2-ETHYLTHALATE	< 4.80	NA	< 4.80	< 4.80	NA	50.0	18.0	< 4.80	< 4.80	< 4.80	37.0	< 4.80	< 4.80	NA
CARBON TETRACHLORIDE	< 0.580	NA	< 0.580	< 0.580	NA	< 0.580	< 0.580	< 0.580	0.870	< 0.580	< 0.580	< 0.580	< 0.580	NA
CHLOROFORM	< 0.500	NA	< 0.500	< 0.500	NA	< 0.500	< 0.500	1.80	2.70	< 0.500	< 0.500	< 0.500	< 0.500	NA
TOLUENE	< 0.500	NA	< 0.500	< 0.500	NA	1.04	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500	< 0.500	NA
1,1,1-TRICHLOROETHANE	< 0.500	NA	< 0.500	< 0.500	NA	< 0.500	< 0.500	1.40	1.00	< 0.500	< 0.500	< 0.500	< 0.500	NA
TRICHLOROETHYLENE	< 0.500	NA	< 0.500	< 0.500	NA	< 0.500	< 0.500	10.3	10.3	< 0.500	< 0.500	< 0.500	< 0.500	NA
TPHC	< 199	NA	313	194	NA	< 188	< 185	< 197	< 192	< 180	< 190	< 201	< 184	NA
<b>COLIFORM BACTERIA (org/100ml)</b>														
TOTAL	0	NA	0	0	NA	40	1	0	NA	1	10	0	0	NA
FECAL	0	NA	0	0	NA	0	0	0	NA	0	0	0	0	NA

ANALYTES	WWTMW-06	WWTMW-06 filter'd	WWTMW-07	WWTMW-07 filter'd	WWTMW-08	WWTMW-08 filter'd	WWTMW-09	WWTMW-09 filter'd	WWTMW-10	WWTMW-11	WWTMW-12	WWTMW-13	WWTMW-13 filter'd	WWTMW-14
<b>ORGANICS (ug/L)</b>														
BIS(2-ETHYLTHALATE	< 4.80	NA	< 4.80	NA	< 4.80	NA	11.0	NA	7.30	4.50	< 4.80	< 4.80	NA	5.00
CARBON TETRACHLORIDE	< 0.580	NA	< 0.580	NA	< 0.580	NA	< 0.580	NA	< 0.580	< 0.580	< 0.580	< 0.580	NA	< 0.580
CHLOROFORM	< 0.500	NA	< 0.500	NA	< 0.500	NA	< 0.500	NA	< 0.500	< 0.500	< 0.500	< 0.500	NA	0.660
TOLUENE	< 0.500	NA	< 0.500	NA	< 0.500	NA	< 0.500	NA	< 0.500	3.99	< 0.500	< 0.500	NA	< 0.500
1,1,1-TRICHLOROETHANE	< 0.500	NA	< 0.500	NA	< 0.500	NA	< 0.500	NA	< 0.500	< 0.500	< 0.500	< 0.500	NA	< 0.500
TRICHLOROETHYLENE	< 0.500	NA	< 0.500	NA	< 0.500	NA	< 0.500	NA	< 0.500	< 0.500	< 0.500	< 0.500	NA	< 0.500
TPHC	< 206	NA	< 190	NA	< 182	NA	< 201	NA	< 192	< 182	< 190	< 183	NA	< 188
<b>COLIFORM BACTERIA (org/100ml)</b>														
TOTAL	15	NA	0	NA	1	NA	0	NA	0	3	4	0	NA	0
FECAL	0	NA	0	NA	0	NA	0	NA	0	0	0	0	NA	0

NOTES: TABLE LISTS DETECTED ANALYTES ONLY - SEE PROJECT ANALYTE LIST FOR SUMMARY  
NA = NOT ANALYZED

**TABLE 4-3**  
**TRICHLOROETHYLENE IN GROUNDWATER**  
**SA 21 - MONITORING WELL WWTMW-02**

**FORT DEVENS**

<b>SAMPLING DATE</b>	<b>CONCENTRATION (ug/L)</b>
FEBRUARY 21, 1990	ND <sup>1</sup>
MAY 30, 1990	ND
AUGUST 16, 1990	ND
NOVEMBER 27, 1990	ND
FEBRUARY 12, 1991	ND
MAY 1991 <sup>2</sup>	
MAY 23, 1991	8
JULY 9, 1991 <sup>3</sup>	61
AUGUST 28, 1991	34
NOVEMBER 20, 1991	19
MARCH 18, 1992	< 4
MAY 28, 1992	10
JULY 16, 1992	14
AUGUST 25, 1992	16
NOVEMBER 30, 1992	8
JANUARY 5, 1993	10.3
JUNE 25, 1993	12
AUGUST 19, 1993	3.5

<sup>1</sup> Not detected above the detection limit of 4 ug/L

<sup>2</sup> Hypalon liner installed

<sup>3</sup> Resampled due to elevated trichloroethylene concentration May 23

Source: Installation quarterly groundwater monitoring reports (various)

TABLE 4-4  
INORGANIC ANALYTES IN GROUNDWATER - ROUND 1 (July 1992)  
GROUP 5 GROUNDWATER MONITORING WELLS

FORT DEVENS

ANALYTE	BACK- GROUND	G5M-92- 01X	G5M-92- 02X	G5M-92- 03B	WWTMW- 01	WWTMW- 01A	WWTMW- 02	WWTMW- 02A	WWTMW- 03	WWTMW- 04	WWTMW- 05
<b>INORGANICS (ug/L)</b>											
ALUMINUM	6870	29300	1430	7470	2330	228	1760	811	287	2970	12800
ARSENIC	10.5	150	7.57	35.4	9.81	16.2	6.08	<2.54	50.5	46.8	11.1
BARIUM	39.6	186	21.3	62.3	12.4	28.5	113	50.6	33.0	46.3	44.8
CADMIUM	4.01	<4.01	<4.01	<4.01	<4.01	<4.01	<4.01	<4.01	<4.01	<4.01	<4.01
CALCIUM	14700	19700	20900	50300	7140	30500	74600	37100	33400	32600	4440
CHROMIUM	14.7	59.6	<6.02	28.4	6.04	8.01	6.32	7.86	<6.02	6.46	28.1
COBALT	25.0	58.4	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0
COPPER	8.09	98.0	<8.09	21.1	<8.09	<8.09	10.4	<8.09	10.2	<8.09	18.7
IRON	9100	56900	2330	14500	3250	356	1350	1560	266	3040	14900
LEAD	4.25	6.62	2.28	9.11	1.95	<1.26	1.41	2.93	1.84	3.58	11.5
MAGNESIUM	3480	12000	3590	9550	1890	4970	6370	4450	4640	5630	4180
MANGANESE	291	2290	81.8	1040	75.4	490	267	315	1200	403	427
MERCURY	0.243	<0.243	<0.243	<0.243	<0.243	<0.243	<0.243	<0.243	<0.243	<0.243	<0.243
NICKEL	34.3	145	<34.3	52.4	<34.3	<34.3	<34.3	<34.3	<34.3	<34.3	<34.3
POTASSIUM	2370	8960	2370	5610	1980	5940	7010	12700	7750	9610	2590
SILVER	4.60	4.93	<4.60	<4.60	<4.60	<4.60	<4.60	<4.60	<4.60	<4.60	<4.60
SODIUM	10800	3620	1830	3510	11300	38400	24100	43700	36900	39000	2370
VANADIUM	11.0	54.0	<11.0	18.8	<11.0	<11.0	<11.0	<11.0	<11.0	<11.0	18.4
ZINC	21.1	149	<21.1	58.6	<21.1	59.5	410	28	<21.1	48.5	35.8
<b>EXPLOSIVES (ug/L)</b>											
NITROGLYCERINE		<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0	<10.0
2,4 - DINITROTOLUENE		<0.064	<0.064	<0.064	<0.064	<0.064	0.131	<0.064	<0.064	<0.064	<0.064
<b>ANIONS/CATIONS (ug/L)</b>											
BICARBONATE		40.3	31700	28100	42700	40300	22000	84200	124000	40300	18300
CHLORIDE		<2120	<2120	<2120	3490	44000	31000	60000	60000	50000	<2120
SULFATE		<10000	<10000	23000	<10000	17900	138000	33800	24200	32700	<10000
NITRATE/NITRITE		200	1000	850	390	13000	19000	13000	4500	13000	15.7
KJELDAHL NITROGEN,TKN		210	<183	<183	<183	1140	3240	2480	9500	486	229
TOTAL PHOSPHOROUS		990	79.2	178	82.2	356	54.4	60.4	1500	297	277
ALKALINITY		33000	26000	23000	35000	33000	18000	69000	102000	33000	15000
<b>OTHER (ug/L)</b>											
HARDNESS		54000	82000	70000	24000	56000	48000	120000	104000	106000	22000
TOTAL SUSPENDED SOLIDS		521000	57000	267000	20000	10000	6000	56000	12000	43000	373000

NOTES:  = GREATER THAN BACKGROUND CONCENTRATION  
TABLE LIST DETECTED ANALYTES ONLY - SEE PROJECT ANALYTE LIST FOR SUMMARY

TABLE 4-4 (continued)  
INORGANIC ANALYTES IN GROUNDWATER - ROUND 1 (July 1992)  
GROUP 5 GROUNDWATER MONITORING WELLS

FORT DEVENS

ANALYTE	BACK - GROUND	WWTMW - 06	WWTMW - 07	WWTMW - 08	WWTMW - 09	WWTMW - 10	WWTMW - 11	WWTMW - 12	WWTMW - 13	WWTMW - 13D	WWTMW - 14
<b>INORGANICS (ug/L)</b>											
ALUMINUM	6870	47400	70400	3320	1920	514	<141	<141	713	5570	9130
ARSENIC	10.5	11.5	180	19.2	5.76	10.4	<2.54	<2.54	3.20	7.57	15.2
BARIUM	39.6	165	51.3	25.1	39.6	27.8	5.62	<5.00	10.3	28.6	46.3
CADMIUM	4.01	<4.01	<4.01	<4.01	14.9	13.8	<4.01	<4.01	<4.01	<4.01	<4.01
CALCIUM	14700	18300	62100	11400	11700	7950	54100	9210	2920	3820	2560
CHROMIUM	14.7	195	1040	12.8	9.40	<6.02	<6.02	<6.02	6.46	13.8	18.7
COBALT	25.0	43.8	84.4	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0	<25.0
COPPER	8.09	81.0	18.5	9.73	<8.09	<8.09	<8.09	<8.09	<8.09	8.98	<8.09
IRON	9100	81200	90000	6320	3590	3720	<38.8	47.5	886	6770	9250
LEAD	4.25	29.2	81.3	5.42	2.60	1.52	<1.26	<1.26	1.84	4.45	5.75
MAGNESIUM	3480	29200	93400	3090	3440	1300	6520	1340	618	2160	1970
MANGANESE	291	1020	1830	195	909	236	7330	3.08	53.7	154	226
MERCURY	0.243	<0.243	<0.243	<0.243	<0.243	<0.243	<0.243	<0.243	1.31	<0.243	<0.243
NICKEL	34.3	188	369	<34.3	<34.3	<34.3	<34.3	<34.3	<34.3	<34.3	<34.3
POTASSIUM	2370	9570	3080	2150	885	835	8410	932	726	1440	1980
SILVER	4.60	<4.60	<4.60	<4.60	<4.60	<4.60	<4.60	<4.60	<4.60	<4.60	<4.60
SODIUM	10800	4240	2050	2360	9870	7050	54600	4340	4320	4900	2100
VANADIUM	11.0	66.5	189	<11.0	<11.0	<11.0	<11.0	<11.0	<11.0	<11.0	14.5
ZINC	21.1	176	181	25.5	174	236	<21.1	<21.1	<21.1	<21.1	32.0
<b>EXPLOSIVES (ug/L)</b>											
NITROGLYCERINE		<10.0	<10.0	<10.0	<10.0	<10.0	140	<10.0	<10.0	<10.0	<10.0
2,4 - DINITROTOLUENE		<0.064	<0.064	<0.064	<0.064	<0.064	<0.064	<0.064	<0.064	<0.064	<0.064
<b>ANIONS/CATIONS (ug/L)</b>											
BICARBONATE		28100	7320	36600	34200	17100	283000	37800	12200	17100	9760
CHLORIDE		<2120	<2120	<2120	14600	7180	71000	<2120	6140	6000	<2120
SULFATE		<10000	<10000	<10000	19700	<10000	24700	<10000	<10000	<10000	<10000
NITRATE/NITRITE		<10.0	12.3	52.4	68.8	920	<10.0	1700	66.8	40.4	<10.0
KJELDAHL NITROGEN,TKN		<183	<183	<183	295	171	876	<183	<183	<183	171
TOTAL PHOSPHOROUS		485	3000	140	96.0	71.3	<13.3	<13.3	248	99.0	109
ALKALINITY		23000	6000	30000	28000	14000	232000	31000	10000	14000	8000
<b>OTHER (ug/L)</b>											
HARDNESS		36000	48000	72000	46000	32000	178000	36000	18000	22000	10000
TOTAL SUSPENDED SOLIDS		503000	733000	143000	125000	15000	<4000	10000	30000	199000	25000

NOTES:   = GREATER THAN BACKGROUND CONCENTRATION  
TABLE LIST DETECTED ANALYTES ONLY - SEE PROJECT ANALYTE LIST FOR SUMMARY

TABLE 4-5  
INORGANIC ANALYTES IN GROUNDWATER - ROUNDS 2 & 3 (Oct 1992/Jan 1993)  
GROUP 5 GROUNDWATER MONITORING WELLS

FORT DEVENS

ANALYTES	BACK- GROUND	GSM-92- 01X filter'd	GSM-92- 02X	GSM-92- 03B	GSM-92- 03B filter'd	WWTMW- 01	WWTMW- 01A	WWTMW- 02	WWTMW- 02 dup	WWTMW- 02A	WWTMW- 03	WWTMW- 04	WWTMW- 05	WWTMW- 05 filter'd
<b>INORGANICS (ug/L)</b>														
ALUMINUM	6870	42200	724	18700	3230	< 141	3900	208	650	680	1110	6150	8710	< 141
ANTIMONY	3.03	3.84	< 3.03	< 3.03	< 3.03	< 3.03	< 3.03	< 3.03	< 3.03	< 3.03	< 3.03	< 3.03	< 3.03	< 3.03
ARSENIC	10.5	83.9	4.26	48.4	15.6	< 2.54	11.9	15.1	< 2.54	< 2.54	46.4	69.7	22.5	< 2.54
BARIUM	39.6	266	18.8	89.3	30.8	13.1	21.9	56.7	81.3	122	38.1	51.4	33.4	< 500
CADMIUM	4.01	< 4.01	< 4.01	< 4.01	< 4.01	< 4.01	< 4.01	< 4.01	< 4.01	< 4.01	< 4.01	< 4.01	< 4.01	< 4.01
CALCIUM	14700	21800	17300	25800	52600	49600	12800	38100	145000	41600	34300	29700	4330	3480
CHROMIUM	14.7	87.2	< 6.02	37.7	9.79	< 6.02	9.25	< 6.02	< 6.02	< 6.02	< 6.02	8.83	16.1	< 6.02
COBALT	25.0	93.7	< 25.0	30.3	< 25.0	< 25.0	< 25.0	< 25.0	< 25.0	< 25.0	< 25.0	< 25.0	< 25.0	< 25.0
COPPER	8.09	143	< 8.09	45.9	< 8.09	< 8.09	< 8.09	< 8.09	11.0	10.6	< 8.09	8.43	8.57	< 8.09
IRON	9100	84400	1480	32000	5920	104	5720	276	300	368	1040	7430	10300	< 38.8
LEAD	4.25	78.0	2.28	27.0	3.80	< 1.26	3.36	< 1.26	2.06	2.17	1.84	8.03	7.92	< 1.26
MAGNESIUM	3480	17400	1820	9920	6750	4810	3400	5920	11700	11800	5010	5600	3510	1600
MANGANESE	291	3270	235	1140	558	178	142	587	1520	1530	1400	653	322	675
NICKEL	34.3	213	< 34.3	85.6	< 34.3	< 34.3	< 34.3	< 34.3	87.2	83.7	< 34.3	42.4	< 34.3	< 34.3
POTASSIUM	2370	11200	3300	6060	5160	3840	2580	8170	8640	8580	7360	10100	2540	789
SILVER	4.60	6.22	< 4.60	< 4.60	< 4.60	< 4.60	< 4.60	< 4.60	< 4.60	< 4.60	< 4.60	< 4.60	< 4.60	< 4.60
SODIUM	10800	4450	2640	3230	3630	3260	21100	38500	22700	46000	48400	41600	2330	1890
VANADIUM	11.0	71.8	< 11.0	33.8	12.1	< 11.0	< 11.0	< 11.0	< 11.0	< 11.0	< 11.0	< 11.0	12.9	< 11.0
ZINC	21.1	258	44.4	94.9	112	30.0	65.0	103	501	503	< 21.1	94.6	48.6	< 21.1
<b>EXPLOSIVES (ug/L)</b>														
NITROGLYCERINE		< 10.0	NA	< 10.0	< 10.0	NA	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	< 10.0	NA
<b>ANIONS/CATIONS (ug/L)</b>														
BICARBONATE		50000	NA	98000	160000	NA	46000	105000	38000	33000	81000	18000	149000	NA
CHLORIDE		< 2120	NA	< 2120	< 2120	NA	35000	52000	25400	25700	48000	48000	< 2120	NA
SULFATE		< 10000	NA	< 10000	15000	NA	< 10000	19700	253000	253000	33700	25200	< 10000	NA
NITRATE/NITRITE		107	NA	590	830	NA	360	21000	47000	68000	21000	30000	45.5	NA
KJELDAHL NITROGEN		267	NA	590	276	NA	< 183	1520	771	819	2480	657	< 183	NA
TOTAL PHOSPHOROUS		2000	NA	990	208	NA	139	347	24.8	21.8	990	990	590	NA
ALKALINITY		41000	NA	80000	131000	NA	38000	86000	31000	27000	66000	15000	122000	NA
<b>OTHER (ug/L)</b>														
HARDNESS		57500	NA	75500	171000	NA	46800	116000	364000	414000	102000	78000	15200	NA
TSS		1330000	NA	876000	156000	NA	153000	4000	5000	12000	46000	10100000	224000	NA

NOTES: TABLE LISTS DETECTED ANALYTES ONLY - SEE PROJECT ANALYTE LIST FOR SUMMARY  
NA = NOT ANALYZED  
[ ] = GREATER THAN BACKGROUND CONCENTRATION

IGSWEL52.WK1  
03/22/93



TABLE 4-5 (continued)  
INORGANIC ANALYTES IN GROUNDWATER - ROUNDS 2 & 3 (Oct 1992/Jan 1993)  
GROUP 5 GROUNDWATER MONITORING WELLS

FORT DEVENS

ANALYTES	BACK- GROUND	WWTMW- 06	WWTMW- 08 filter'd	WWTMW- 07	WWTMW- 07 filter'd	WWTMW- 08	WWTMW- 08 filter'd	WWTMW- 09	WWTMW- 09 filter'd	WWTMW- 10	WWTMW- 11	WWTMW- 12	WWTMW- 13	WWTMW- 13 filter'd	WWTMW- 14
<b>INORGANICS (ug/L)</b>															
ALUMINUM	6870	12000	< 141	17800	< 141	6240	< 141	1200	< 141	326	< 141	155	1040	< 141	2920
ANTIMONY	3.03	< 3.03	< 3.03	< 3.03	< 3.03	< 3.03	< 3.03	< 3.03	< 3.03	< 3.03	< 3.03	< 3.03	< 3.03	< 3.03	< 3.03
ARSENIC	10.5	23.1	< 2.54	220	240	27.5	< 2.54	5.44	< 2.54	11.9	< 2.54	< 2.54	4.69	< 2.54	14.8
BARIUM	39.6	47.0	15.6	58.0	< 5.00	26.7	< 5.00	39.8	30.4	23.9	7.30	< 5.00	14.7	10.0	22.9
CADMIUM	4.01	< 4.01	< 4.01	< 4.01	< 4.01	< 4.01	< 4.01	8.47	7.31	< 4.01	< 4.01	< 4.01	< 4.01	< 4.01	< 4.01
CALCIUM	14700	11600	9740	32400	18800	14000	13400	14700	13700	8750	61000	9320	3280	3200	1960
CHROMIUM	14.7	29.5	< 6.02	252	< 6.02	20.7	< 6.02	< 6.02	< 6.02	< 6.02	< 6.02	< 6.02	< 6.02	< 6.02	< 6.02
COBALT	25.0	< 25.0	< 25.0	34.7	< 25.0	< 25.0	< 25.0	< 25.0	< 25.0	< 25.0	< 25.0	< 25.0	< 25.0	< 25.0	< 25.0
COPPER	8.09	16.1	8.51	< 8.09	< 8.09	14.7	< 8.09	< 8.09	< 8.09	< 8.09	< 8.09	< 8.09	< 8.09	< 8.09	< 8.09
IRON	9100	19800	< 38.8	22600	50.1	12700	< 38.8	2090	203	6700	75.6	194	1200	< 38.8	3190
LEAD	4.25	12.1	< 1.26	31.6	< 1.26	10.3	< 1.26	1.74	< 1.26	< 1.26	< 1.26	< 1.26	< 1.26	< 1.26	2.28
MAGNESIUM	3480	8870	1920	25400	3470	5090	1870	3840	3310	1410	7150	1380	741	< 500	857
MANGANESE	291	341	11.7	629	9.11	411	5.82	587	463	424	7810	20.1	79.1	49.3	108
NICKEL	34.3	46.9	< 34.3	104	< 34.3	< 34.3	< 34.3	< 34.3	< 34.3	< 34.3	< 34.3	< 34.3	< 34.3	< 34.3	< 34.3
POTASSIUM	2370	3210	767	2210	1530	2520	1060	1660	1320	1510	9230	1520	1580	1150	1570
SILVER	4.60	< 4.60	< 4.60	< 4.60	< 4.60	< 4.60	< 4.60	< 4.60	< 4.60	< 4.60	< 4.60	< 4.60	< 4.60	< 4.60	< 4.60
SODIUM	10800	3240	2740	2040	2350	3230	3190	15500	13900	8730	57000	4630	5310	5390	1910
VANADIUM	11.0	16.1	< 11.0	49.5	< 11.0	14.5	< 11.0	< 11.0	< 11.0	< 11.0	< 11.0	< 11.0	< 11.0	< 11.0	< 11.0
ZINC	21.1	61.3	< 21.1	75.0	31.4	81.5	40.5	165	131	117	48.8	114	40.8	85.1	53.1
<b>EXPLOSIVES (ug/L)</b>															
NITROGLYCERINE		< 10.0	NA	< 10.0	NA	< 10.0	NA	< 10.0	NA	< 10.0	63.5	< 10.0	< 10.0	NA	< 10.0
<b>ANIONS/CATIONS (ug/L)</b>															
BICARBONATE		171000	NA	93000	NA	54000	NA	45000	NA	87000	183000	24000	12000	NA	6000
CHLORIDE		< 2120	NA	< 2120	NA	2770	NA	23200	NA	10500	71000	< 2120	6880	NA	< 2120
SULFATE		< 10000	NA	< 10000	NA	< 10000	NA	15600	NA	11700	25200	< 10000	< 10000	NA	< 10000
NITRATE/NITRITE		< 10.0	NA	11.1	NA	52.7	NA	460	NA	2200	< 10.0	2000	36.0	NA	< 10.0
KJELDAHL NITROGEN		171	NA	< 183	NA	< 183	NA	190	NA	< 183	895	< 183	< 183	NA	171
TOTAL PHOSPHOROUS		406	NA	590	NA	228	NA	51.5	NA	39.6	< 13.3	< 13.3	68.3	NA	356
ALKALINITY		140000	NA	76000	NA	44000	NA	37000	NA	71000	150000	20000	10000	NA	5000
<b>OTHER (ug/L)</b>															
HARDNESS		32000	NA	69600	NA	43600	NA	51200	NA	26400	198000	27200	15200	NA	9600
TSS		295000	NA	543000	NA	261000	NA	34000	NA	16000	6000	4000	30000	NA	107000

NOTES: TABLE LISTS DETECTED ANALYTES ONLY - SEE PROJECT ANALYTE LIST FOR SUMMARY  
NA = NOT ANALYZED

[ ] = GREATER THAN BACKGROUND CONCENTRATION

TABLE 4-6  
ANALYTES IN SURFACE WATER  
GROUP 5 - NASHUA RIVER

FORT DEVENS

ANALYTE	G5D-92-01X	G5D-92-02X	G5D-92-03X	G5D-92-04X	G5D-92-05X	G5D-92-06X	G5D-92-07X	G5D-92-07DUP	G5D-92-08X	G5D-92-09X	G5D-92-10X
<b>ORGANICS (ug/L)</b>											
BIS(2-ETHYLHEXYL)PHTHALATE	<4.80	<4.80	<4.80	<4.80	12.0	<4.80	<4.80	<4.80	<4.80	<4.80	<4.80
CARBON DISULFIDE	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	0.740
TOLUENE	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	0.820
1,1,1-TRICHLOROETHANE	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	<0.500	1.50	<0.500	<0.500
<b>INORGANICS (ug/L)</b>											
ALUMINUM	<141	<141	142	<141	<141	<141	<141	144	<141	180	<141
ARSENIC	2.88	3.62	3.09	<2.54	2.98	2.88	3.09	<2.54	2.98	2.77	<2.54
BARIUM	18.1	5.59	17.4	18.8	18.1	17.2	17.2	17.9	20.0	17.7	29.7
CALCIUM	11300	10100	11400	11700	11700	12500	12500	12900	14300	13800	8220
IRON	851	175	811	789	773	779	786	824	691	786	574
LEAD	5.10	<1.26	4.23	4.01	6.51	<1.26	5.21	5.75	3.90	2.71	5.75
MAGNESIUM	1650	2800	1730	1750	1730	1810	1790	1860	1900	1910	1190
MANGANESE	106	12.8	103	109	111	125	126	131	117	153	169
POTASSIUM	1600	<375	1580	1950	2020	2120	2570	2710	2860	2420	714
SODIUM	20600	19000	20900	21700	21900	23400	23700	24300	32200	26400	10800
<b>ANIONS/CATIONS (ug/L)</b>											
CHLORIDE	38000	35000	38000	40000	40000	42000	44000	44000	55000	46000	16900
SULFATE	12000	<10000	11600	12500	12500	12500	12600	12500	14100	11800	<10000
NITRATE/NITRITE	940	190	910	1000	920	880	910	860	1000	1100	<100
KJELDAHL NITROGEN	648	276	581	657	686	771	1140	952	810	781	2670
TOTAL PHOSPHOROUS	97.0	13.9	92.1	83.2	86.1	139	148	139	129	139	188
ALKALINITY	52000	35000	34000	27000	57000	36000	31000	35000	44000	46000	22000
<b>OTHER (ug/L)</b>											
HARDNESS	36800	38800	36800	38600	45000	38400	40600	40600	46000	43000	26200
TSS	9000	<4000	4000	11000	8000	<4000	17000	7000	<4000	9000	31000
TOTAL COLIFORM BACTERIA (org/100ml)	1050	350	500	500	200	1100	2350	2050	2250	2500	200
FECAL COLIFORM BACTERIA (org/100ml)	30	105	86	100	12	55	54	66	145	400	5

NOTES: TABLE LIST DETECTED ANALYTES ONLY - SEE PROJECT ANALYTE LIST FOR SUMMARY

TABLE 4-7  
ANALYTES IN SEDIMENT  
GROUP 5 - NASHUA RIVER

FORT DEVENS

ANALYTE	G5D-92-01X	G5D-92-02X	G5D-92-03X	G5D-92-04X	G5D-92-05X	G5D-92-06X	G5D-92-07X	G5D-92-08X	G5D-92-09X	G5D-92-10X
<b>INORGANICS (ug/g)</b>										
ALUMINUM	6830	1480	7390	6090	4750	3560	6540	4750	6300	4600
ANTIMONY	5.46	<1.09	6.58	9.92	7.19	4.86	3.73	5.87	<1.09	<1.09
ARSENIC	7.03	3.34	7.70	4.11	4.70	6.62	29.0	4.57	7.34	6.20
BARIUM	89.9	10.9	87.6	46.4	60.6	37.8	87.7	21.0	28.6	16.8
BERYLLIUM	1.24	<0.500	1.08	0.79	<0.500	<0.500	0.978	<0.500	0.977	<0.500
CADMIUM	9.35	<0.700	10.0	2.34	10.6	2.59	15.0	<0.700	<0.700	<0.700
CALCIUM	1450	360	1800	916	840	1040	1720	612	761	336
CHROMIUM	52.7	<4.05	54.8	53.3	54.8	50.2	81.5	12.7	15.4	7.48
COBALT	5.16	<1.42	5.27	2.74	3.11	2.71	5.06	13.6	2.46	2.40
COPPER	67.1	<0.965	69.5	31.6	45.5	42.3	84.9	8.68	5.51	5.61
IRON	9700	2230	9350	7030	5710	5290	7810	9690	7260	5860
LEAD	100	1.82	98.0	110	73.0	110	41.0	12.3	10.2	8.07
MAGNESIUM	2030	422	2000	1690	1380	1040	1810	1790	1990	1080
MANGANESE	195	47.8	180	126	101	248	122	895	86.6	59.9
MERCURY	0.598	<0.050	0.704	0.504	0.37	0.511	0.718	0.094	0.068	0.468
NICKEL	13.0	2.58	12.7	9.33	9.99	10.5	15.1	15.4	7.88	8.00
POTASSIUM	700	<100	713	594	551	394	741	452	599	297
SELENIUM	<0.250	<0.250	<0.250	0.589	<0.250	0.549	<0.250	<0.250	<0.250	<0.250
SILVER	2.34	<0.589	3.46	1.98	1.68	1.39	2.88	<0.589	<0.589	<0.589
SODIUM	342	222	360	277	247	249	363	210	242	189
VANADIUM	13.6	<3.39	14.6	11.7	9.33	7.04	14.1	7.17	11.1	5.55
ZINC	169	13.0	176	55.6	100	61.2	179	26.5	40.3	20.7
<b>ORGANICS (ug/g)</b>										
ACETONE	<0.0170	<0.0170	<0.0170	<0.0170	0.039	<0.0170	<0.0170	<0.0170	<0.0170	<0.0170
TOLUENE	<0.00078	<0.00078	<0.00078	<0.00078	<0.00078	<0.00078	<0.00078	<0.00078	<0.00078	0.0214
ACENAPHTHYLENE	<0.300	<0.033	<0.700	<0.300	<0.165	<0.165	0.408	<0.066	<0.033	<0.033
BENZO[A]PYRENE	<2.00	<0.250	<5.00	<2.00	<1.25	<1.25	3.21	<0.250	<0.250	<0.250
BENZO[K]FLOURANTHENE	<0.700	<0.066	<1.00	<0.700	<0.330	<0.330	0.900	<0.132	<0.066	<0.066
CHRYSENE	<1.00	<0.120	<2.00	<1.00	<0.600	<0.600	2.20	<0.240	<0.120	<0.120
DICHLOROBENZENES	7.80	ND 0.100	ND 0.100	ND 0.100	ND 0.100	ND 0.100	ND 0.100	ND 0.100	ND 0.100	ND 0.100
FLOURANTHENE	2.00	<0.068	<1.00	<0.700	1.68	0.855	1.04	<0.136	<0.068	<0.068
PHENANTHRENE	1.00	<0.033	<0.700	<0.300	0.375	<0.165	0.650	<0.070	<0.033	<0.033
PYRENE	2.00	<0.033	<0.700	<0.300	1.72	<0.165	2.13	<0.070	<0.033	<0.033
<b>OTHER (ug/g)</b>										
TPHC	325	54.9	346	162	359	357	441	55.6	47.7	<27.9
TOTAL ORGANIC CARBON	17900	1610	14200	9360	8370	8640	11900	2550	4200	4340

NOTES: TABLE LIST DETECTED ANALYTES ONLY - SEE PROJECT ANALYTE LIST FOR SUMMARY  
ND = NOT DETECTED

TABLE 4-8

## FORT DEVENS

ANALYTE	BORING	21S-92-01X	21S-92-02X	21S-93-03X	21S-93-04X	21S-93-05X	21S-93-06X	21S-93-07X
	DEPTH	0	0	0	0	0	0	0
INORGANICS (ug/g)								
ALUMINUM	Background	6130	5300	14000	17100	11000	1710	12100
ANTIMONY	NA	3.22	2.86	<1.09	<1.09	<1.09	<1.09	<1.09
ARSENIC	21	8.99	30.0	28	37	27	26	43
BARIUM	42.5	283	460	57.3	51.4	51.9	<5.18	290
BERYLLIUM	0.347	<0.500	<0.500	2.57	2.25	1.98	<0.500	1.75
CADMIUM	2.00	3.14	1.51	2.87	1.27	2.88	<0.700	7.85
CALCIUM	1400	3980	3230	1240	1090	2030	156	3140
CHROMIUM	31	29.5	37.5	36.6	39.7	31.5	<4.05	56.5
COBALT	NA	5.35	5.35	6.22	6.89	9.03	<1.42	6.67
COPPER	8.39	242	295	34.9	27	31.7	2.66	429
IRON	15000	12200	10800	17500	20200	21000	1630	16000
LEAD	34.4	140	130	14.8	92	46	53	180
MAGNESIUM	5600	2770	2500	3000	2950	4020	293	2550
MANGANESE	300	280	161	614	463	632	40.1	341
MERCURY	0.22	5.90	7.70	0.601	0.577	0.410	0.352	4.6
NICKEL	14.0	18.3	11.8	19.8	18.0	34.7	<1.71	22.1
POTASSIUM	1700	359	392	847	1050	914	222	545
SELENIUM	NA	1.18	1.12	0.604	0.582	<0.250	<0.250	1.22
SILVER	0.086	38.0	46.0	1.51	<0.589	1.32	<0.589	54.0
SODIUM	131	238	244	339	393	316	367	330
VANADIUM	28.7	17.0	15.9	33.3	33.6	22.6	<3.39	33.5
ZINC	35.5	289	207	152	85.7	109	<8.03	361
OTHER (ug/g)								
TOTAL PETROLEUM HYDROCARBONS		1310	1490	181	133	112	163	470
TOTAL ORGANIC CARBON		131000	43800	NA	NA	NA	NA	NA

NOTES: TABLE LISTS DETECTED ANALYTES ONLY -- SEE PROJECT ANALYTE LIST FOR SUMMARY

NA = NOT ANALYZED

☐ = GREATER THAN BACKGROUND CONCENTRATION

TABLE 4-8 (continued)  
ANALYTES IN SURFACE SOIL  
SA 21 - SLUDGE DRYING BEDS

FORT DEVENS

ANALYTE	BORING	21S-93-08X	21S-93-09X	21S-93-10X	21S-93-11X	21S-93-12X	21B-93-01X	21B-93-02X
DEPTH		0	0	0	0	0	2	2
<b>INORGANICS (ug/g)</b>								
<b>Background</b>								
ALUMINUM	15000	14400	7230	13000	10500	11700	9590	7670
ANTIMONY	NA	<1.09	2.01	<1.09	<1.09	<1.09	<1.09	<1.09
ARSENIC	21	53	22	35	21	25	17	12
BARIUM	42.5	151	229	150	35.7	153	19.6	19.2
BERYLLIUM	0.347	2.13	1.32	2.24	1.67	1.76	1.24	1.22
CADMIUM	2.00	3.81	3.71	4.34	3.09	9.44	<0.700	<0.700
CALCIUM	1400	1100	1590	1310	645	1420	599	788
CHROMIUM	31	43.5	41.4	48.1	30.1	55	15.0	12.2
COBALT	NA	7.08	3.36	11.7	6.60	7.80	4.73	4.09
COPPER	8.39	268	399	274	51.9	197	10.9	9.3
IRON	15000	19500	11800	27100	18900	13200	10800	9090
LEAD	34.4	98	110	220	93	220	4.80	4.49
MAGNESIUM	5600	2810	1870	3810	1820	2150	2640	1940
MANGANESE	300	311	124	708	544	589	193	112
MERCURY	0.22	4.3	7.9	6.7	0.778	6.4	0.128	<0.050
NICKEL	14.0	16.5	14.6	33.7	20.4	17.6	16.1	11.3
POTASSIUM	1700	700	386	567	449	505	518	691
SELENIUM	NA	0.915	1.42	1.22	0.544	1.08	<0.250	<0.250
SILVER	0.086	22	47	29	3.63	21	<0.589	<0.589
SODIUM	131	357	328	341	308	395	230	204
VANADIUM	28.7	36.6	28.3	36.8	31.4	27.3	13.4	11.3
ZINC	35.5	96.8	93.1	109	58.5	131	75.4	25.2
<b>OTHER (ug/g)</b>								
TOTAL PETROLEUM HYDROCARBONS		795	944	586	193	418	<28.5	<28.3
TOTAL ORGANIC CARBON		NA	NA	NA	NA	NA	NA	NA

NOTES: TABLE LISTS DETECTED ANALYTES ONLY - SEE PROJECT ANALYTE LIST FOR SUMMARY

□ = ABOVE BACKGROUND CONCENTRATION

NA = NOT ANALYZED

TABLE 5-1  
HUMAN HEALTH PRE EVALUATION OF GROUNDWATER  
SA 19, 20, AND 21 MONITORING WELLS

FORT DEVENS

Analyte	Groundwater Background Concentration	Maximum Detected Concentration [a]	Average Detected Concentration	Maximum Exceeds Background?	Drinking Water Standard/Guideline [b] (ug/l)	Maximum Exceeds Standard/Guideline?
<b>Organics (ug/l)</b>						
acetone		18.0			3,000	NO
trichloroethylene		14.0			5	YES
carbon tetrachloride		1.40			5	NO
chloroform		2.7			5	NO
bis(2-ethylhexyl)phthalate		37.0			6.1	YES
toluene		0.54			1,000	NO
1,1,1-trichloroethane		2.2			200	NO
<b>Inorganics (ug/l)</b>						
aluminum	6,870	6,150		NO	50-200	YES
arsenic	10.5	69.7	21.1	YES	50	YES
barium	39.6	122		YES	2,000	NO
cadmium	4.01	14.9	4.2	YES	5	YES
calcium	14,700	145,000		YES	NA	NA
chromium	14.7	9.40		NO	100	NO
copper	8.09	11.0		YES	1,000	NO
iron	9,100	7,430		NO	300	YES
lead	4.25	8.03		YES	15	NO
magnesium	3,480	11,800		YES	NA	NA
manganese	291	1,530		YES	50	YES
nickel	34.3	87.2		YES	100	NO
potassium	2,370	15,600		YES	NA	NA
sodium	10,800	48,400	30,030	YES	28,400	YES
zinc	21.1	503		YES	5,000	NO
<b>Anions/Cations (ug/l)</b>						
nitrate/nitrite		68,000			10,000	YES

NOTES:

[a] Maximum from either Round 1 or Rounds 2 & 3. Only unfiltered samples are used for inorganics.

[b] Standard/Guideline selected in order of the following preference: MA drinking water standard, EPA drinking water standard, Region III Tap Water Concentration.

[c] SA 19, 20, and 21 are represented by the following downgradient monitoring wells: WWTMW-01A, WWTMW-02, WWTMW-02A, WWTMW-03, WWTMW-04, WWTMW-09 and WWTMW-10.

ND Not detected

NA Not available

TABLE 5-2  
HUMAN HEALTH PRE EVALUATION OF SURFACE SOIL  
STUDY AREA 21 - SLUDGE DRYING BEDS

FORT DEVENS

Analyte	Soil Background Concentration [a]	Detected Concentration [b]		Frequency of Detection	Maximum Exceeds Background ?	Region III Residential Soil Concentrations (ug/g)	Maximum Exceeds Region III Concentrations ?
		Average	Maximum				
Inorganics (ug/g)							
aluminum	15,000	10,800	20,000	15/15	YES	230,000	NO
antimony	NA	2.70	3.22	3/15	NA	31	NO
arsenic	21	27.3	53.0	15/15	YES	0.68	YES
barium	42.5	142	460	14/15	YES	5,500	NO
beryllium	0.347	1.86	2.57	12/15	YES	0.28	YES
cadmium	2.00	3.76	9.44	12/15	YES	39	NO
chromium	31	36.3	56.5	14/15	YES	390	NO
cobalt	NA	6.52	11.7	14/15	NA	NA	NO
copper	8.39	153	429	15/15	YES	2,900	NO
lead	34.4	96.1	220	15/15	YES	500	NO
manganese	300	358	708	15/15	YES	396	YES
mercury	0.22	3.33	7.90	14/15	YES	23	NO
nickel	14.0	19.4	34.7	14/15	YES	1,600	NO
selenium	NA	0.989	1.42	10/15	NA	390	NO
silver	0.086	26.3	54.0	10/15	YES	390	NO
vanadium	28.7	26.4	36.8	14/15	YES	550	NO
zinc	35.5	132	361	14/15	YES	23,000	NO

NOTES:

[a] Base - wide background soil inorganics database.

[b] Surface soil samples from from sampling station 21S-92-01X, 21S-92-02X, 21S-92-03X through 21S-93-12X, 21B-93-01X, and 21B-93-02X.

NA = not available.

TABLE 6--1  
ECOLOGICAL PRE EVALUATION OF SURFACE SOIL  
STUDY AREA 21 - SLUDGE DRYING BEDS

FORT DEVENS

Analyte	Soil Background Concentration [a]	Detected Concentration [b]		Frequency of Detection	Maximum Exceeds Background ?	Ecological Benchmark (ug/g)	Maximum Exceeds Benchmark ?
		Average	Maximum				
Inorganics (ug/g)	15,000	10800	20,000	15/15	YES	14,964	YES
aluminum	NA	2.7	3.22	3/15	NA	7	NO
antimony	21	27.3	53.0	15/15	YES	33	YES
arsenic	42.5	142	460	14/15	YES	42.6	YES
barium	0.347	1.86	2.57	12/15	YES	0.88	YES
beryllium	2.00	3.76	9.44	12/15	YES	2	YES
cadmium	31	36.3	56.5	14/15	YES	830	NO
chromium	NA	6.52	11.7	14/15	NA	50	NO
cobalt	8.39	153	429	15/15	YES	34	YES
copper	34.4	96.1	220	15/15	YES	34.4	YES
lead	300	358	708	15/15	YES	1,500	NO
manganese	0.22	3.3	7.90	14/15	YES	3.6	YES
mercury	14.0	19.4	34.7	14/15	YES	31	NO
nickel	NA	0.989	1.42	10/15	NA	0.48	YES
selenium	0.086	26.3	54	10/15	YES	72	NO
silver	28.7	26.4	36.8	14/15	YES	28.7	YES
vanadium	35.5	132	361	14/15	YES	640	NO
zinc							

NOTES:

[a] Base-wide background soil inorganics database.

[b] Surface soil samples from from sampling station 21S-92-01X and 21S-92-02X.

NA = not available.



**APPENDIX A**



June 29, 1995

Mr. Charles A. George  
U.S. Army Environmental Center  
Building E4480  
ATTN: SFIM-AEC-BCA  
Aberdeen Proving Ground, MD 21020-5401

**SUBJECT: Study Areas 21 and 58 - Supplemental Sampling Results**

Dear Mr. George:

As you recall, concerns about the Army's recommendations for no further action (NFA) at the subject study areas were presented by the regulators during the March 31, 1995 BCT meeting. Supplemental sampling activities were agreed to for each of the two study areas to allow further assessment of the Army's NFA determinations.

We have completed the sampling activities at these two study areas, and level III laboratory results are now available. A brief discussion of sampling activities and the interpretation of laboratory results is provided below by study area. Supporting documentation is attached.

#### **Study Area 21 - Sludge Drying Beds**

During the March 31, 1995 BCT meeting, the regulators argued that the lateral extent of contaminant migration down slope of the discharge pipe was not adequately characterized by the available data, particularly for the surface water body (vernal pool) located east of the pipe. It was agreed that five additional surface soil/sediment samples would be collected at SA 21 to resolve the issue by further mapping the extent of contaminant migration. Potential impacts to the "vernal pool" were to be considered in the selection of sampling locations.

Three surface soil and two sediment sampling locations were selected jointly by USEPA, MADEP, and the Army in the field on April 6, 1995. The attached figures show the surveyed locations of all SA 21 sampling stations established to date. Local topography was also surveyed and plotted to assess surface drainage flow paths. The newly established sampling locations are designated on the map as surface soils 21S-95-13X, -14X, and -15X, and sediments 21D-95-01X, and 21D-95-02X.

ABB Environmental Services, Inc.



Mr. Charles George

June 29, 1995

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Samples were collected and submitted for laboratory analysis of Project Analyte List inorganics. The results are presented in the attached table along with those from earlier investigations at SA 21.

During earlier investigations at SA 21, several contaminants were identified as being directly related to the discharge of supernatant, by virtue of their distribution in surface soils relative to the discharge pipe. In particular, copper, mercury, silver, and barium were assumed to be attributed to releases from the pipe. The contaminant concentrations detected in the supplemental rounds of soil sampling support these earlier findings. These analytes, shown in the attached concentration contour maps, are present at elevated concentrations in a low-lying area south and west of the limits of migration identified in earlier investigations. The distributions are consistent with a topographically controlled migration pathway. Concentrations of these supernatant analytes support the theory that the majority of these contaminants were derived from the evaporation/infiltration of supernatant ponded in the low-lying area. There is little evidence of contaminant migration beyond the low-lying area to the "vernal pool" located further east.

Other inorganic analytes such as cadmium, chromium, and lead show a distinctly different distribution (see attached maps). These contaminants exhibit increasing concentrations to the east in a distribution pattern that mimics topography. The lowest concentrations of these analytes are observed near the pipe suggesting a source other than supernatant discharge. Further, concentrations of cadmium, chromium, and lead detected in Nashua River sediments collected east of SA 21 are similar in magnitude to the highest concentrations observed at SA 21.

In an effort to re-evaluate the impacts of these contaminants on ecological receptors, ABB-ES has recalculated maximum and average concentration values for each of the inorganic analytes detected using the newly-acquired data. The Ecological PRE has been revised accordingly. The PRE concludes, that with the exception of cadmium and possibly aluminum, no analytes exceed their respective screening values. Copper, mercury, silver, and barium (the supernatant indicator analytes), do not exceed their respective screening levels. A memo summarizing the findings of the revised ecological PRE is attached.

In considering the analytes that pose potential threats to ecological receptors, the cadmium distribution clearly shows a pattern inconsistent with an SA 21 source. These findings are consistent with the earlier findings reported in the SA 21 Final No Further Action Decision Document where many of the inorganic analytes were assumed to be attributable to Nashua River contamination.



Mr. Charles George

June 29, 1995

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Based on these findings, it is not likely that the analytes derived from the release of supernatant discharge at SA 21 pose a significant potential threat to ecological receptors. Therefore, ABB-ES recommends that the Army maintain the no further action determination for SA 21.

#### **Study Area 58 - Buildings 2648 and 2650 Fuel Oil Spill (LUST Site)**

Concerns were raised by the MADEP regarding the lack of testing documentation on excavated soils derived from the SA 58 UST removals that were used to backfill the tank excavations. A request for more information on the nature of contaminants in these soils was made during the March 31, 1995 meeting. Also, VOCs were detected in the Round 1 groundwater sample collected from upgradient well 58M-92-01X. The absence of VOCs in the Round 2 sample lead the Army to conclude that the Round 1 contaminants were laboratory artifacts. The regulators have requested that a groundwater sample be collected from the well and tested for VOCs to confirm the Army's position.

It was agreed in the March 31, 1995 BCT meeting that three soil samples would be collected from various depth intervals within each of the backfilled tank excavations for the purpose of characterizing the level of TPHC contamination in backfilled soils. One sample of groundwater would also be collected from the upgradient monitoring well for analysis of VOCs. The results of this supplemental sampling effort are documented in the attached laboratory results.

The results showed that backfilled soil contains concentrations of TPHC varying from below the detection limit to a maximum of 91.2  $\mu\text{g/g}$  (10 feet below grade in the excavation beneath former Building 2648. The results suggest that at least some residual contamination exists in the backfilled material (likely derived from releases from the former USTs) but the concentrations are well below the MCP Method 1 S-1/GW-1 standard of 500  $\mu\text{g/g}$  for TPHC.

Laboratory results also showed that the groundwater sample collected from the upgradient well 58M-92-01X exhibited no detectable concentrations of VOCs, confirming the Army's position that the Round 1 VOC detections were laboratory artifacts.

Based on the findings discussed above, and in consideration of PRE findings reported in the Final No Further Action Decision Document, the concentrations of petroleum hydrocarbons associated with the former leaking USTs pose no significant threats to human health or the environment. Therefore, ABB-ES recommends that the Army maintain the no further action determination for SA 58.



Mr. Charles George  
June 29, 1995  
Page 4

If ABB-ES can be of further assistance to you in this matter, or if you questions or comments, please contact me at your earliest convenience.

Sincerely,

ABB Environmental Services, Inc.

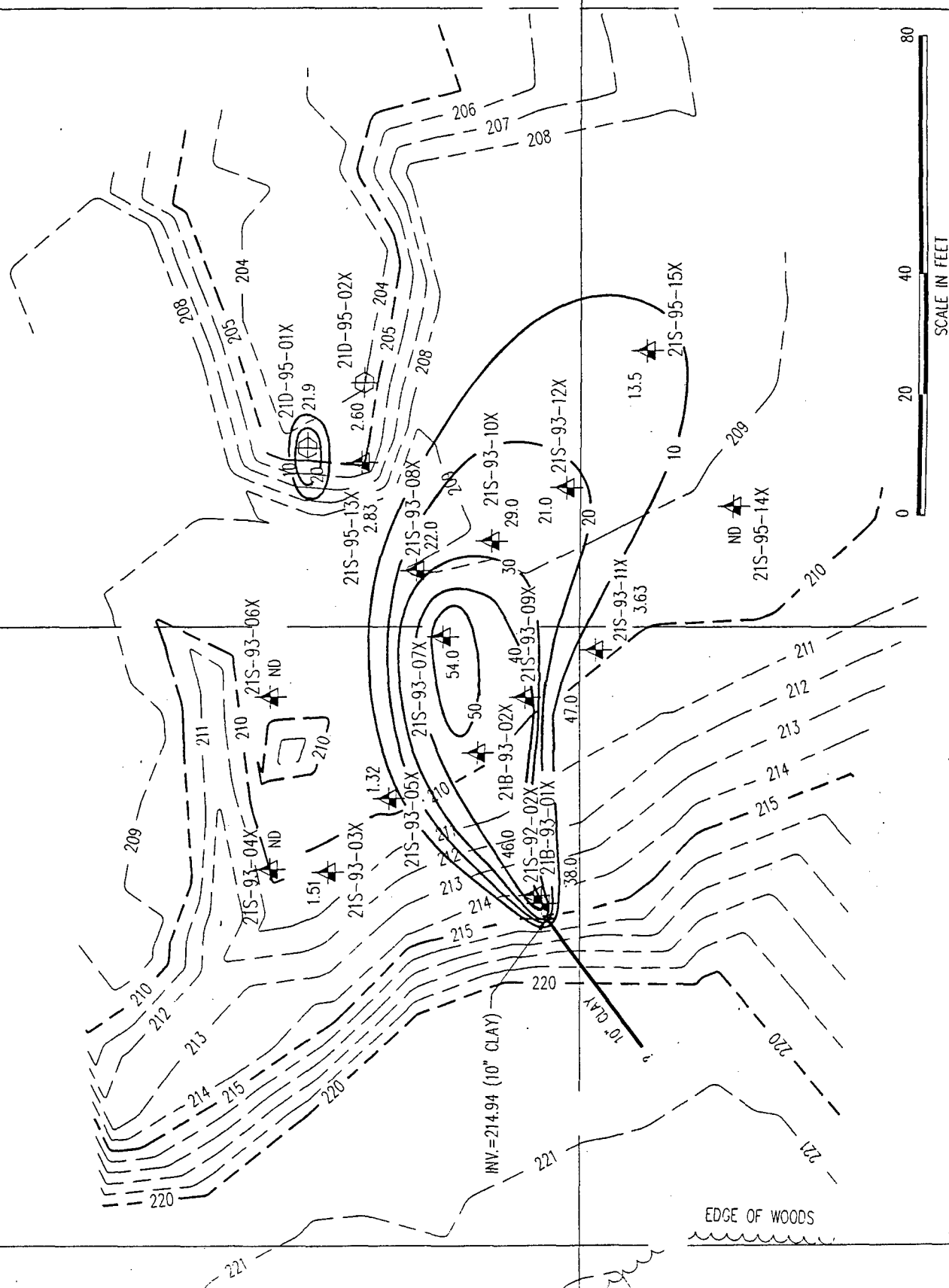
A handwritten signature in cursive script, reading 'Benjamin J. Rice'.

Benjamin J. Rice  
Task Manager

Attachments

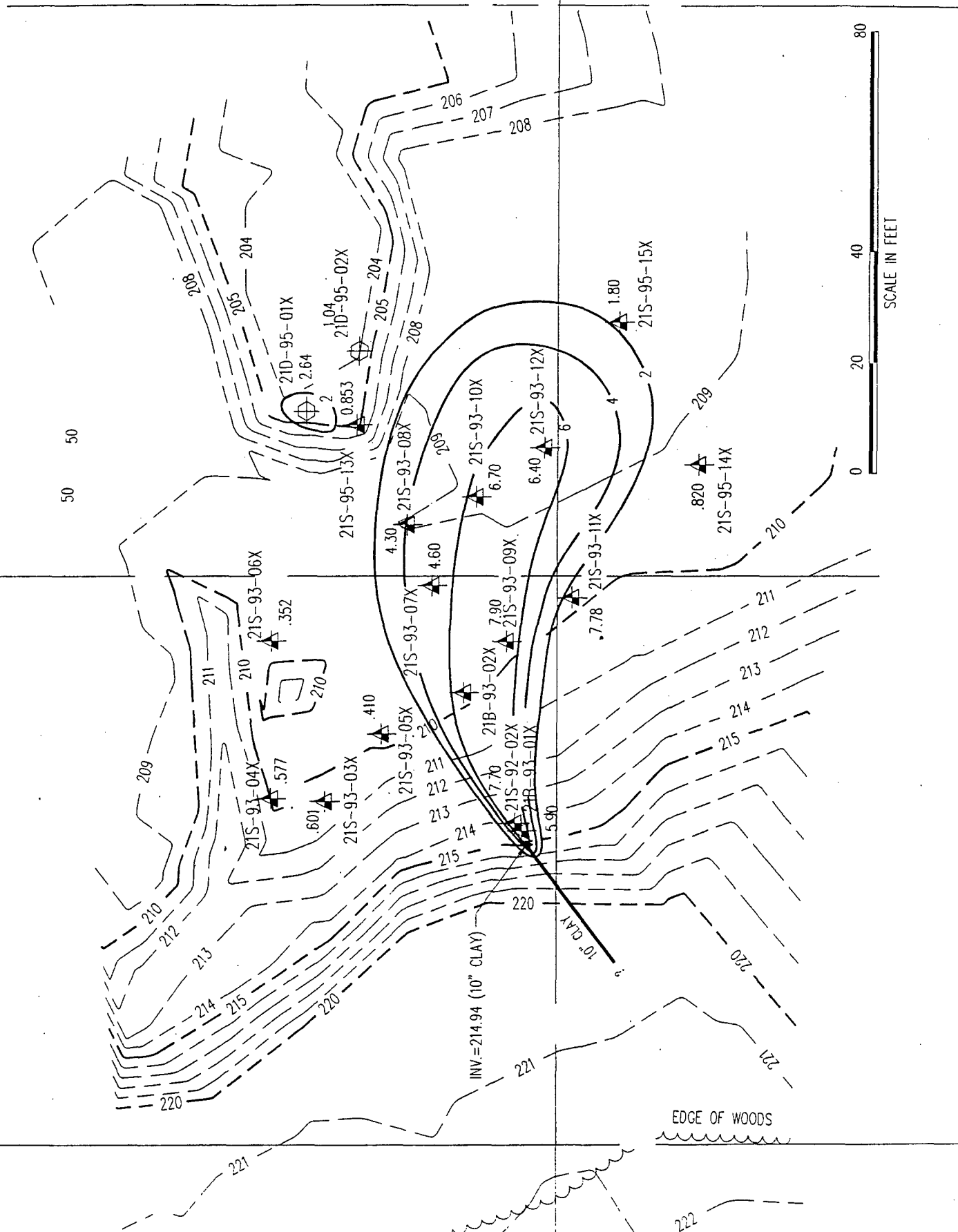
cc: J. Chambers, Fort Devens BEC  
J. Byrne, USEPA  
S. Mierzykowski, USFWS  
L. Welsh, MADEP  
M. Applebee, NED  
P. Exner, ABB-ES  
J. Snowden, ABB-ES

# SILVER



- NOTES:**
1. BENCHMARK: SUPPLIED AND ESTABLISHED BY TBM - R.R. SPK. #121  
TBM - CAPPED PIN #
  2. VISIBLE DETAIL, UTILIZED BY ACTUAL FIELD SURVEYING ELECTRIC CONDUITS, 1 CONDUITS PER MANHOLE

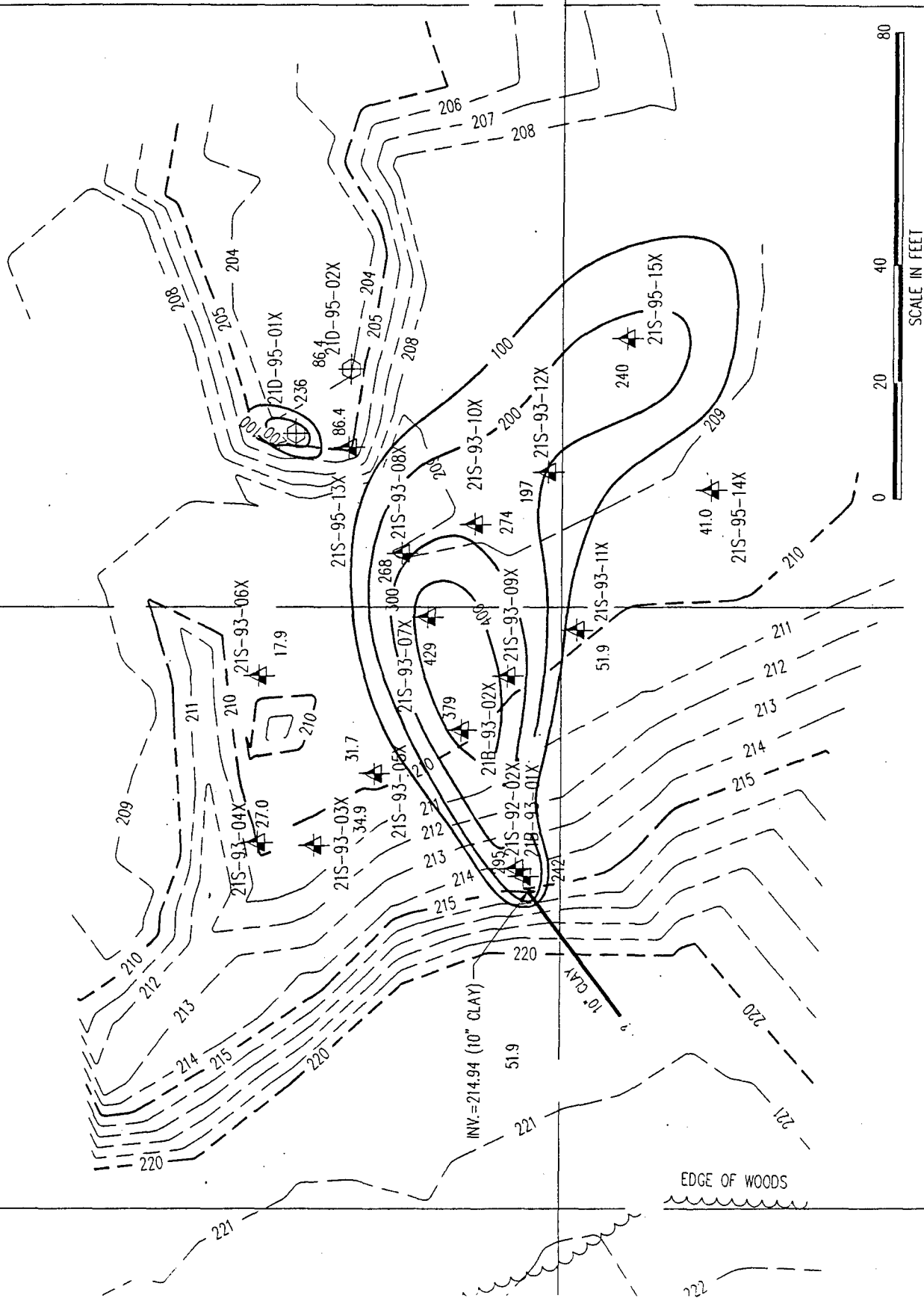
# MERCURY



## NOTES:

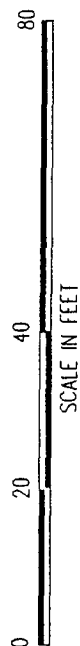
1. BENCHMARK: 51 AND ESTABLISHED: 10M - R.R. 5 10M - CAPT
2. VISIBLE DETAIL BY ACTUAL 1:1 ELECTRIC CO. CONDUITS, 6"

# COPPER



## NOTES:

1. BENCHMARK SUPPLIED AND ESTABLISHED BY TBM - R.R. SPK. #1 TBM - CAPPED PH
2. VISIBLE DETAIL, UTILI BY ACTUAL FIELD 'S ELECTRIC CONDUIT, CONDUITS, GAS MAI SERVICES (IF ANY) I MAY NOT BE ACCUR

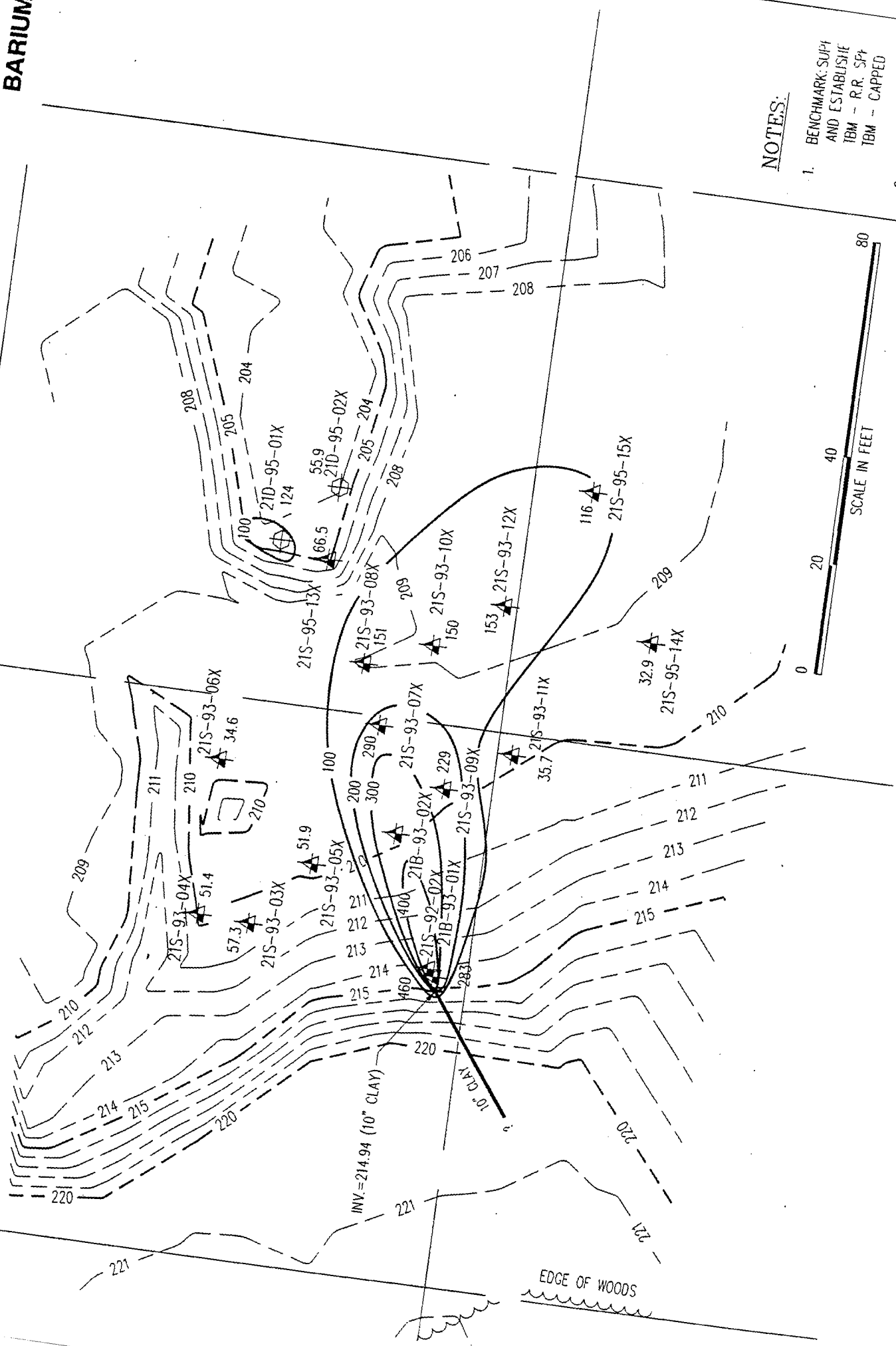


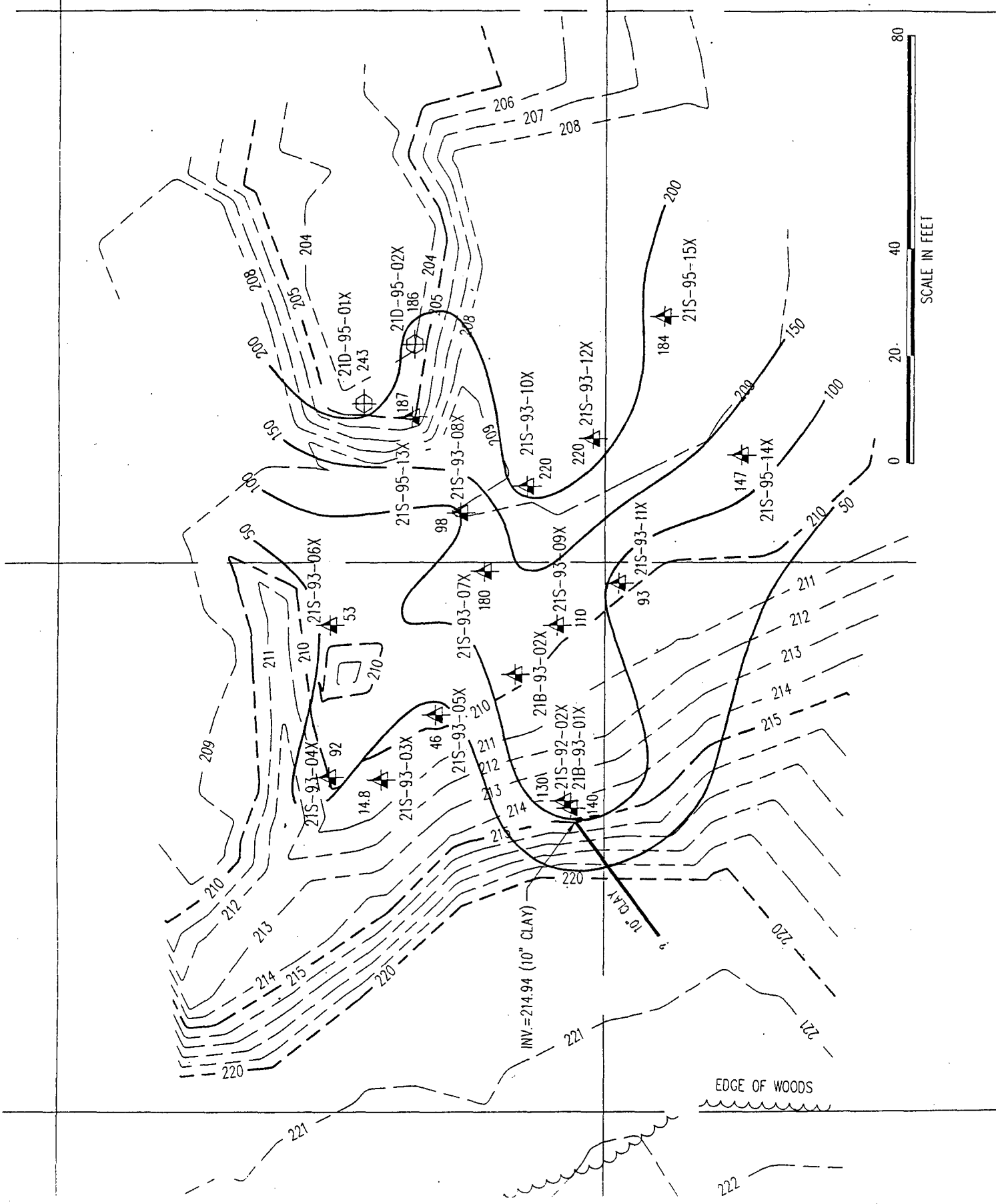


# BARIUM

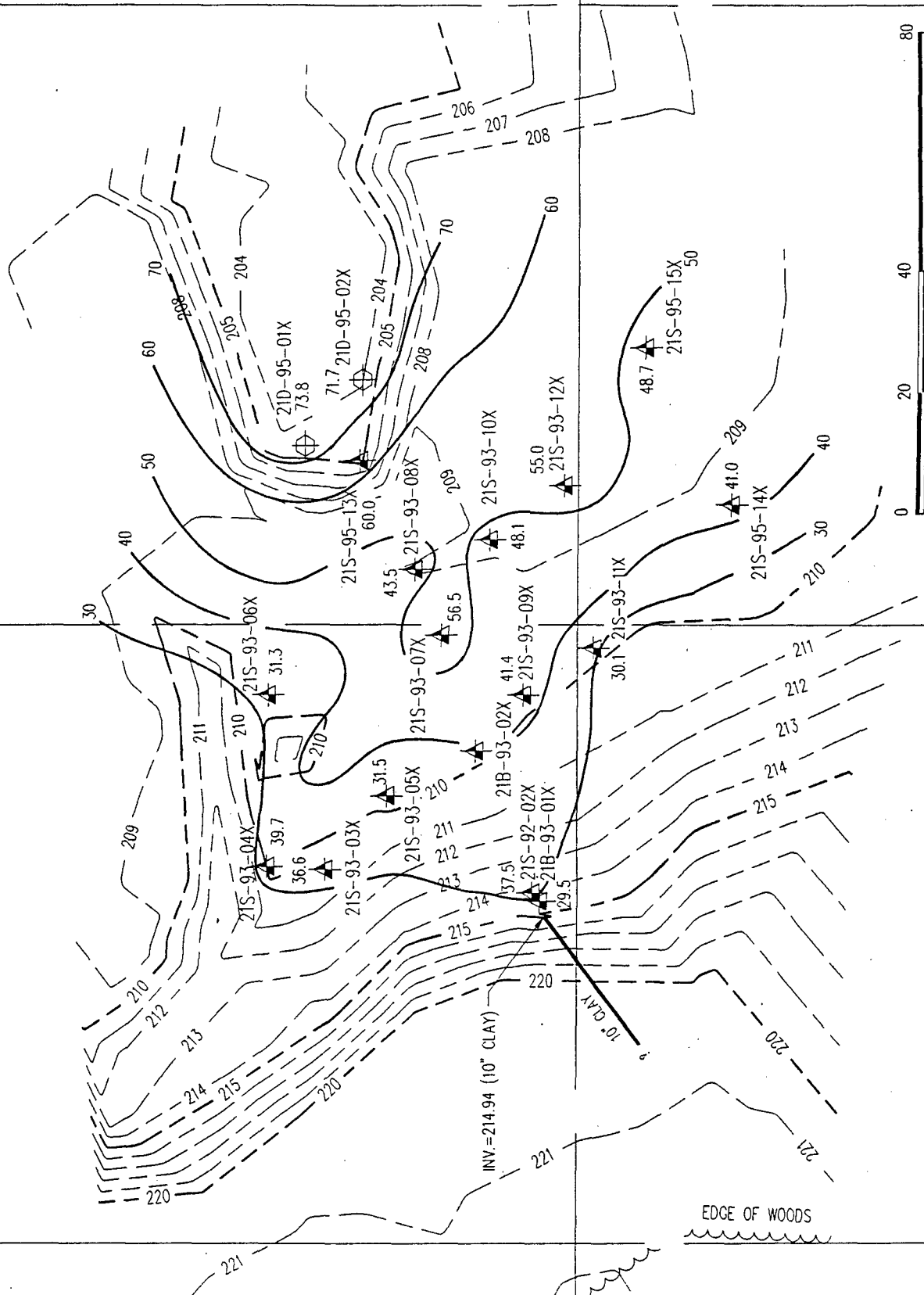
## NOTES:

1. BENCHMARK: SUPP  
AND ESTABLISH  
TBM - R.R. SP  
TBM - CAPPED
2. VISIBLE DETAIL, L  
BY ACTUAL FIELD  
ELECTRIC CONDU  
CONDUITS, GAS I  
SERVICES (1/1 41)





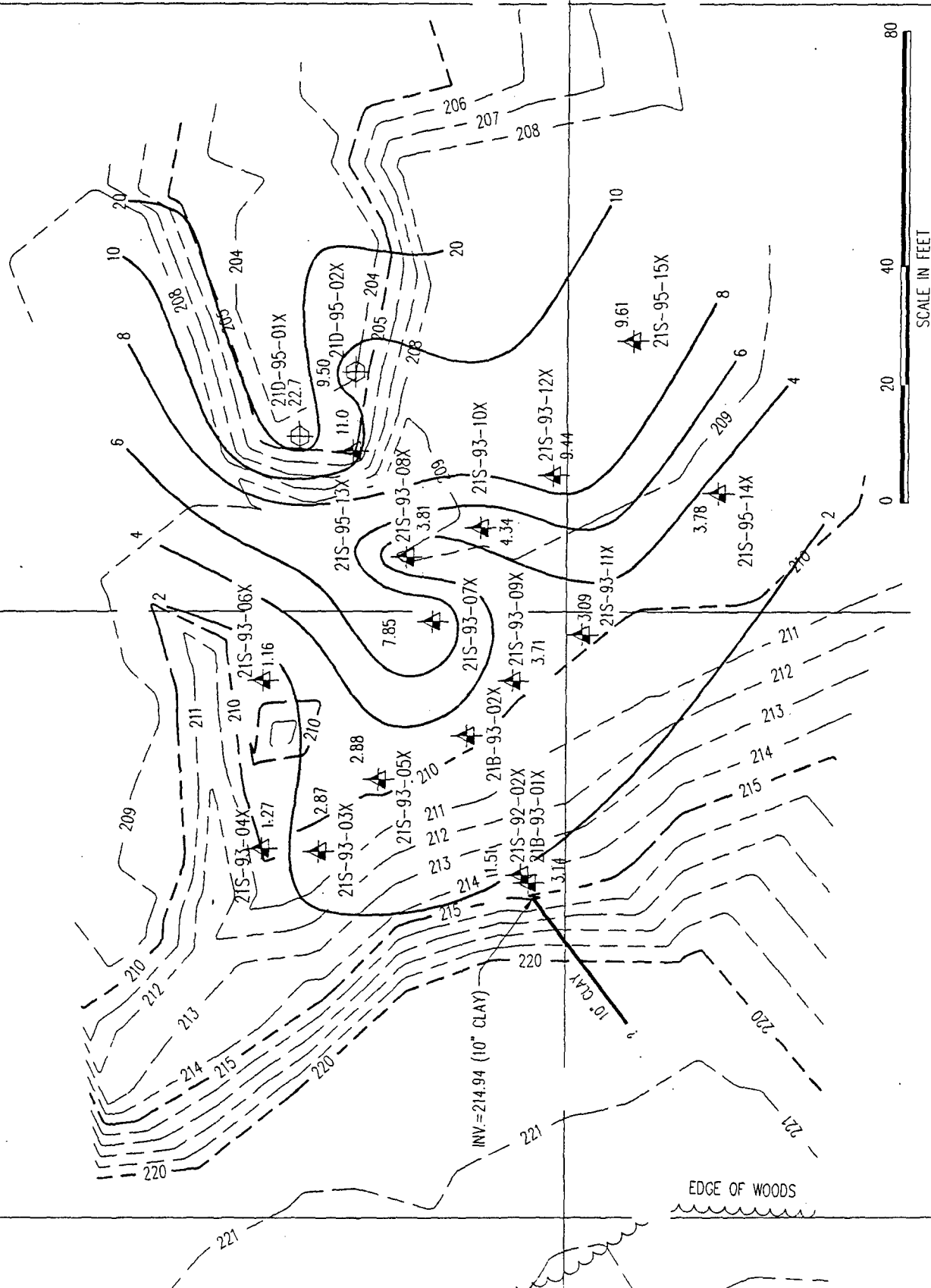
# CHROMIUM



## NOTES:

1. BENCHMARK: SUPPLIED BY ABE AND ESTABLISHED BY GOLDEN TBM - R.R. SPK. #121  
TBM - CAPPED PIN #140
2. VISIBLE DETAIL, UTILITIES AND BY ACTUAL FIELD SURVEY DU ELECTRIC CONDUITS, TELEPHO CONDUITS, GAS MAINS AND SERVICES (IF ANY) NOT VISIB

# CADMIUM



NOTES:

1. BENCHMARK SUPPLIED BY:  
AND ESTABLISHED BY:  
TBM - R.R. SPK. #121  
TBM - CAPPED PIN #114
2. VISIBLE DETAIL, UTILIZED  
BY ACTUAL FIELD SURVEY  
ELECTRIC CONDUITS, (E)  
CONDUITS, GAS MAINS, -  
SERVICES (IF ANY) (F)

TABLE 4-8

## FORT DEVENS

ANALYTE	BORING	21S-92-01X	21S-92-02X	21S-93-03X	21S-93-04X	21S-93-05X	21S-93-06X	21S-93-07X
	DEPTH	0	0	0	0	0	0	0
INORGANICS (ug/g)								
ALUMINUM	Background	6130	5300	14000	17100	11000	1710	12100
ANTIMONY	NA	3.22	2.86	<1.09	<1.09	<1.09	<1.09	<1.09
ARSENIC	21	8.99	30.0	28	37	27	26	43
BARIUM	42.5	283	460	57.3	51.4	51.9	<5.18	290
BERYLLIUM	0.347	<0.500	<0.500	2.57	2.25	1.98	<0.500	1.75
CADMIUM	2.00	3.14	1.51	2.87	1.27	2.88	<0.700	7.85
CALCIUM	1400	3980	3230	1240	1090	2030	156	3140
CHROMIUM	31	29.5	37.5	36.6	39.7	31.5	<4.05	56.5
COBALT	NA	5.35	5.35	6.22	6.89	9.03	<1.42	6.67
COPPER	8.39	242	295	34.9	27	31.7	2.66	429
IRON	15000	12200	10800	17500	20200	21000	1630	16000
LEAD	34.4	140	130	14.8	92	46	53	180
MAGNESIUM	5600	2770	2500	3000	2950	4020	293	2550
MANGANESE	300	280	161	614	463	632	40.1	341
MERCURY	0.22	5.90	7.70	0.601	0.577	0.410	0.352	4.6
NICKEL	14.0	18.3	11.8	19.8	18.0	34.7	<1.71	22.1
POTASSIUM	1700	359	392	847	1050	914	222	545
SELENIUM	NA	1.18	1.12	0.604	0.582	<0.250	<0.250	1.22
SILVER	0.086	38.0	46.0	1.51	<0.589	1.32	<0.589	54.0
SODIUM	131	238	244	339	393	316	367	330
VANADIUM	28.7	17.0	15.9	33.3	33.6	22.6	<3.39	33.5
ZINC	35.5	289	207	152	85.7	109	<8.03	361
OTHER (ug/g)								
TOTAL PETROLEUM HYDROCARBONS		1310	1490	181	133	112	163	470
TOTAL ORGANIC CARBON		131000	43800	NA	NA	NA	NA	NA

NOTES: TABLE LISTS DETECTED ANALYTES ONLY - SEE PROJECT ANALYTE LIST FOR SUMMARY

NA = NOT ANALYZED

= GREATER THAN BACKGROUND CONCENTRATION

TABLE 4-8 (continued)  
ANALYTES IN SURFACE SOIL  
SA 21 - SLUDGE DRYING BEDS

FORT DEVENS

ANALYTE	BORING	21S-93-08X	21S-93-09X	21S-93-10X	21S-93-11X	21S-93-12X	21S-95-13X	21S-95-14X
DEPTH		0	0	0	0	0	0	0
INORGANICS (ug/g)								
Background								
ALUMINUM	15000	14400	7230	13000	10500	11700	8590	8140
ANTIMONY	NA	<1.09	2.01	<1.09	<1.09	<1.09	<1.09	4.04
ARSENIC	21	53	22	35	21	25	13.3	26
BARIUM	42.5	151	229	150	35.7	153	66.5	32.9
BERYLLIUM	0.347	2.13	1.32	2.24	1.67	1.76	<0.500	<0.500
CADMIUM	2.00	3.81	3.71	4.34	3.09	9.44	11.0	3.78
CALCIUM	1400	1100	1590	1310	645	1420	3860	722
CHROMIUM	31	43.5	41.4	48.1	30.1	55	60	41
COBALT	NA	7.08	3.36	11.7	6.60	7.80	6.15	6.32
COPPER	8.39	268	399	274	51.9	197	86.4	41.0
IRON	15000	19500	11800	27100	18900	13200	7500	11900
LEAD	34.4	98	110	220	93	220	187	147
MAGNESIUM	5600	2810	1870	3810	1820	2150	1060	1040
MANGANESE	300	311	124	708	544	589	216	341
MERCURY	0.22	4.3	7.9	6.7	0.778	6.4	0.853	0.82
NICKEL	14.0	16.5	14.6	33.7	20.4	17.6	20.9	9.27
POTASSIUM	1700	700	386	567	449	505	<100	175
SELENIUM	NA	0.915	1.42	1.22	0.544	1.08	1.00	0.603
SILVER	0.086	22	47	29	3.63	21	2.83	<0.589
SODIUM	131	357	328	341	308	395	749	375
VANADIUM	28.7	36.6	28.3	36.8	31.4	27.3	16	24.6
ZINC	35.5	96.8	93.1	109	58.5	131	235	51.2
OTHER (ug/g)								
TOTAL PETROLEUM HYDROCARBONS		795	944	586	193	418	NA	NA
TOTAL ORGANIC CARBON		NA	NA	NA	NA	NA	NA	NA

NOTES: TABLE LISTS DETECTED ANALYTES ONLY - SEE PROJECT ANALYTE LIST FOR SUMMARY  
☐ = ABOVE BACKGROUND CONCENTRATION  
 NA = NOT ANALYZED

TABLE 4-8 (continued)  
ANALYTES IN SURFACE SOIL  
SA 21 - SLUDGE DRYING BEDS

FORT DEVENS

ANALYTE	BORING	21S-95-15X		21D-95-01X		21D-95-02X		21B-93-01X		21B-93-02X	
DEPTH		0		0		0		2		2	
INORGANICS (ug/g)											
Background											
ALUMINUM	15000	10400		9120		9100		9590		7670	
ANTIMONY	NA	5.13		5.8		<1.09		<1.09		<1.09	
ARSENIC	21	28		11.1		9.43		17		12	
BARIUM	42.5	116		124		55.9		19.6		19.2	
BERYLLIUM	0.347	<0.500		<0.500		<0.500		1.24		1.22	
CADMIUM	2.00	9.61		22.7		9.50		<0.700		<0.700	
CALCIUM	1400	980		4070		2030		599		788	
CHROMIUM	31	48.7		73.8		71.7		15.0		12.2	
COBALT	NA	6.55		5.67		4.72		4.73		4.09	
COPPER	8.39	240		236		86.4		10.9		9.3	
IRON	15000	12300		6730		6600		10800		9090	
LEAD	34.4	184		243		186		480		4.49	
MAGNESIUM	5600	1060		1210		1080		2640		1940	
MANGANESE	300	203		142		137		193		112	
MERCURY	0.22	1.8		2.64		1.04		0.128		<0.050	
NICKEL	14.0	10.9		20.7		20.6		16.1		11.3	
POTASSIUM	1700	175		<100		<100		518		691	
SELENIUM	NA	0.774		2.06		<0.250		<0.250		<0.250	
SILVER	0.086	13.5		21		2.6		<0.589		<0.589	
SODIUM	131	482		939		637		230		204	
VANADIUM	28.7	37.9		20.6		12.3		13.4		11.3	
ZINC	35.5	102		254		203		75.4		25.2	
OTHER (ug/g)											
TOTAL PETROLEUM HYDROCARBONS		NA		NA		NA		<28.5		<28.3	
TOTAL ORGANIC CARBON		NA		NA		NA		NA		NA	



Inter-Office Correspondence

**ABB-ENVIRONMENTAL SERVICES  
INTERNAL MEMORANDUM**

---

**PROJECT:** Fort Devens Groups 3, 5, & 6  
**TO:** Ben Rice  
**FROM:** John A. Bleiler and Nancy Roka  
**DATE:** 19 June 1995  
**SUBJECT:** Study Area (SA) 21 Ecological Preliminary Risk Evaluation (PRE)

---

In response to your recent request, the ecological PRE for the above-referenced site has been reviewed. The purpose of this review was two-fold: (1) to determine if newly collected surface soil data from SA 21 affect the PRE conclusions; and, (2) to explore the uncertainties in the SA 21 ecological PRE through an evaluation of the toxicological exposure parameters used in the PRE.

The results of the ecological PRE contained in the January, 1995 *No Further Action Decision Document* suggested that ecological receptors may be at risk from exposure to inorganic contamination in the surface soils downgradient of the SA 21 sludge drying beds. Site concentrations exceeded the PRE small mammal ecological screening values for the following metals: aluminum, arsenic, barium, beryllium, cadmium, copper, lead, mercury, selenium, and vanadium.

The following activities were conducted to evaluate the newly collected data, and to reduce the ecological PRE uncertainties:

- Recently collected floodplain soil data were integrated with the existing data set to form a combined data set;
- Summary statistics were calculated on the combined data set (i.e., maximum, average [mean], frequency of detect, and the 95th percent upper confidence limit [95th UCL] on the average [mean]);
- Bioaccumulation, toxicological, and life history exposure assumptions were reviewed and updated using the revised data included in the Railroad Roundhouse and Cold Spring Brook PREs;
- The assumptions regarding the aerial extent of contamination at SA 21 was re-evaluated;
- Revised PRE spreadsheets incorporating site-specific revisions were prepared.



The attached tables present the PRE findings following implementation of the above uncertainty reduction measures.

Maximum concentrations of aluminum and cadmium still exceeded their vertebrate screening values; maximum concentrations of all other metals were below vertebrate screening values.

The maximum exposure point concentration is likely to overestimate risk at SA 21; therefore, the 95th UCL concentrations of aluminum and cadmium were also compared to vertebrate screening values. The aluminum 95th UCL was below background levels, whereas the cadmium 95th UCL was approximately 4 times the vertebrate PCL for cadmium.

In summary, when the maximum concentration is the selected exposure point concentration, both aluminum and cadmium exceed vertebrate screening values. When the 95th UCL on the mean is selected as the exposure point concentration, cadmium is the only metal present in excess of a vertebrate screening value at SA 21.

Please don't hesitate to contact either of us if any questions arise.

---

**DISTRIBUTION:** file

TABLE 6-1  
ECOLOGICAL PRE - SURFACE SOIL  
STUDY AREA 21 - SLUDGE DRYING BEDS

FORT DEVENS

Analyte	Soil Background Concentration [a]	Detected Concentrations [b]		Frequency of Detection	Maximum Exceeds Background ?	Old Benchmark (mg/kg)	New Benchmark (mg/kg)	Maximum Exceeds Old Benchmark?	Maximum Exceeds New Benchmark?
		Average	Maximum						
Inorganics (mg/kg)									
Aluminum	15,000	10,312	20,000	19/19	YES	15,000 [c]	15,000 [c]	YES	YES
Antimony	NA	1.6	5.8	6/19	NA	7	1,531	NO	NO
Arsenic	21	24.9	53	19/19	YES	33	193	YES	NO
Barium	42.5	124	460	19/19	YES	42.6 [c]	11,511	YES	NO
Beryllium	0.347	1.2	2.6	12/19	YES	0.88	390	YES	NO
Cadmium	2.00	5.4	22.7	17/19	YES	2 [c]	3.3	YES	YES
Chromium	31	41.5	73.8	19/19	YES	830	27,629	NO	NO
Cobalt	NA	6.2	11.7	19/19	NA	50	83	NO	NO
Copper	8.39	156	429	19/19	YES	34	1,192	YES	NO
Lead	48.4	123	243	19/19	YES	48.4 [c]	397	YES	NO
Manganese	300	330	708	19/19	YES	1,500	11,963	NO	NO
Mercury	0.22	2.8	7.9	18/19	YES	3.6	19	YES	NO
Nickel	14.0	18.2	34.7	19/19	YES	31	746	YES	NO
Selenium	NA	0.79	2.1	14/19	NA	0.48	2.1	YES	NO
Silver	0.086	16.1	54	14/19	YES	72	350	NO	NO
Vanadium	28.7	24.6	37.9	19/19	YES	28.7 [c]	351	YES	NO
Zinc	35.5	140	361	19/19	YES	640	452	NO	NO
Other Parameters (mg/kg)									
Total Organic Carbon	NA	87,400	131,000	2/2	NA	NA	NA	NA	NA
Total Petroleum Hydrocarbons	NA	485	1,490	12/14	NA	NA	NA	NA	NA

NOTES:

[a] Base-wide background soil inorganics database.

[b] Sample locations include 21S-92-01X, 21S-92-02X, 21S-93-03X through 21S-93-12X, 21S-95-13X through 21S-95-15X, 21D-95-01X, 21D-95-02X, 21B-93-01X, and 21B-93-02X.

[c] Benchmark is less than background, therefore, background was used instead.  
NA = Not Available.

MAXHACRE

TABLE 6-1  
ECOLOGICAL PRE - SURFACE SOIL  
STUDY AREA 21 - SLUDGE DRYING BEDS

FORT DEVENS

Analytic	Soil Background Concentration [a]	Detected Concentration [b]		Frequency of Detection	95th % UCL Exceeds Background ?	Old Benchmark (mg/kg)	New Benchmark (mg/kg)	95th % UCL Exceeds Old Benchmark ?	95th % UCL Exceeds New Benchmark ?
		Average	95th % UCL						
Inorganics (mg/kg)									
Aluminum	15,000	10,312	11,849	19/19	NO	15,000 [c]	15,000 [c]	NO	NO
Antimony	NA	1.6	2.6	6/19	NA	7	1,531	NO	NO
Arsenic	21	24.9	32.1	19/19	YES	33	193	NO	NO
Barium	42.5	124	240	19/19	YES	42.6 [c]	11,511	YES	NO
Beryllium	0.347	1.2	2.5	12/19	YES	0.88	390	YES	NO
Cadmium	2.00	5.4	13.3	17/19	YES	2 [c]	33	YES	YES
Chromium	31	41.5	54.1	19/19	YES	830	27,629	NO	NO
Cobalt	NA	6.2	7.1	19/19	NA	50	83	NO	NO
Copper	8.39	156	429 [d]	19/19	YES	34	1,192	YES	NO
Lead	48.4	123	243 [d]	19/19	YES	48.4 [c]	397	YES	NO
Manganese	300	330	459	19/19	YES	1,500	11,963	NO	NO
Mercury	0.22	2.8	7.9 [d]	18/19	YES	3.6	19	YES	NO
Nickel	14.0	18.2	21.8	19/19	YES	31	746	NO	NO
Selenium	NA	0.79	1.7	14/19	NA	0.48	2.1	YES	NO
Silver	0.086	16.1	54 [d]	14/19	YES	72	350	NO	NO
Vanadium	28.7	24.6	30.3	19/19	YES	28.7 [c]	351	YES	NO
Zinc	35.5	140	217	19/19	YES	640	452	NO	NO
Other Parameters (mg/kg)									
Total Organic Carbon	NA	87,400	NA	2/2	NA	NA	NA	NA	NA
Total Petroleum Hydrocarbons	NA	485	3,361	12/14	NA	NA	NA	NA	NA

NOTES:

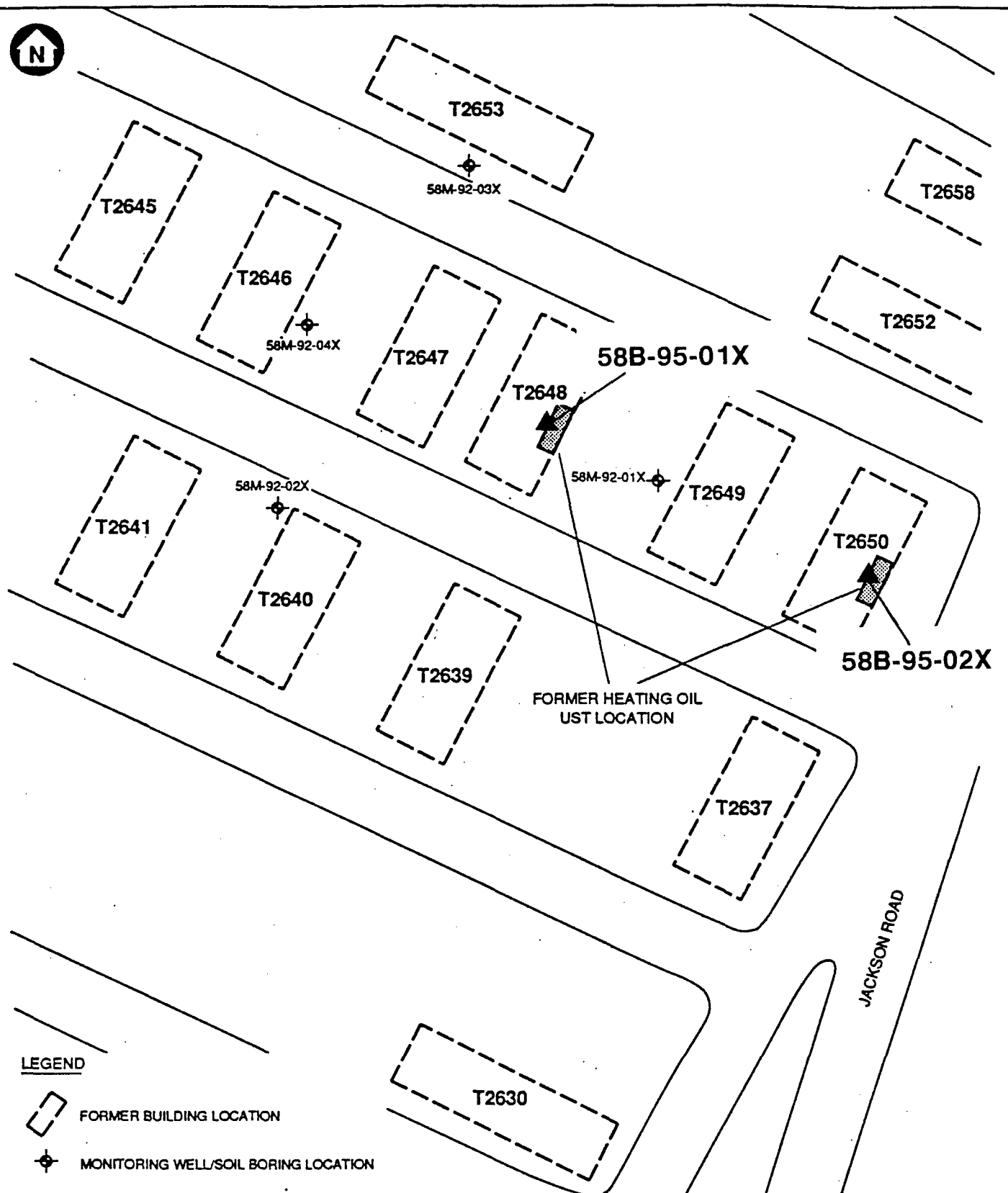
[a] Base-wide background soil inorganics database.

[b] Sample locations include 21S-92-O1X, 21S-92-O2X, 21S-93-O3X through 21S-93-12X, 21S-95-13X through 21S-95-15X, 21D-95-01X, 21D-95-02X, 21B-93-01X, and 21B-93-02X.

[c] Benchmark is less than background, therefore, background was used instead.

[d] Maximum detected concentration was less than the 95th % UCL, therefore, the maximum was used instead.  
NA = Not Available.

UCLHACRE



**LEGEND**

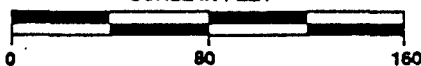


FORMER BUILDING LOCATION



MONITORING WELL/SOIL BORING LOCATION

SCALE IN FEET



ANALYTES IN SOIL  
SA 58 - SUPPLEMENTAL SAMPLING

FORT DEVENS

BORING	DEPTH (feet)	TPHC (ug/g)
58B-95-01X	0.0	< 20.8
	5.0	36.4
	10.0	91.2
58B-95-02X	0.0	24.7
	5.0	35.0
	10.0	< 27.9